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Hide?	Set Name	Query	Hit Count
		<i>DB=PGPB,USPT,USOC,EPAB,JPAB,DWPI,TDBD; PLUR=NO; OP=OR</i>	
<input type="checkbox"/>	L24	L22 and ((search\$ or enquir\$ or inquir\$ or quer\$) same image\$)	145
<input type="checkbox"/>	L23	L22 and ((search\$ or enquir\$ or inquir\$ or quer\$) same image\$)	145
<input type="checkbox"/>	L22	L21 and (display same file\$)	385
<input type="checkbox"/>	L21	((front adj1 page) or (home adj1 page)) same image\$)	1413
		<i>DB=USPT; PLUR=NO; OP=OR</i>	
<input type="checkbox"/>	L20	L19 and ((search\$ or enquir\$ or inquir\$ or quer\$) same image\$)	31
<input type="checkbox"/>	L19	L18 and (display same file\$)	80
<input type="checkbox"/>	L18	(l14 or l15 or l16 or L17) and (((front adj1 page) or (home adj1 page)) same image\$)	118
<input type="checkbox"/>	L17	707/104.1.ccls.	1958
<input type="checkbox"/>	L16	707/1-4.ccls.	4646
<input type="checkbox"/>	L15	715/513-516.ccls.	931
<input type="checkbox"/>	L14	709/200-225.ccls.	9976
<input type="checkbox"/>	L13	L11 and ((home same (page or site)) or (front same (page or site))).ab.	27
<input type="checkbox"/>	L12	(mediation adj1 server)	6
<input type="checkbox"/>	L11	L10 and (imag\$ or picture\$)	916
<input type="checkbox"/>	L10	L9 and (client\$ or user\$ or customer\$)	1256
<input type="checkbox"/>	L9	L6 and (server or server\$)	1260
<input type="checkbox"/>	L8	=19990202	2255
<input type="checkbox"/>	L7	=19990202	1467
<input type="checkbox"/>	L6	=19990202	1436
<input type="checkbox"/>	L5	L2 and ((home same (page or site)) or (front same (page or site)))	3937
<input type="checkbox"/>	L4	L2 and ((home near (page or site)) or (front near (page or site)))	2446
<input type="checkbox"/>	L3	L2 and ((home adj1 (page or site)) or (front adj1 (page or site)))	2385
<input type="checkbox"/>	L2	((world adj1 wide adj1 web) or www or internet)	43300
<input type="checkbox"/>	L1	6167382.pn.	1

END OF SEARCH HISTORY

09/421,446



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US Patent & Trademark Office



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Results 1 - 20 of 152 **short listing**



1 2 3 4 5 6 7 8



1 Model-driven development of Web applications: the AutoWeb system 90%



Piero Fraternali , Paolo Paolini

ACM Transactions on Information Systems (TOIS) October 2000

Volume 18 Issue 4

This paper describes a methodology for the development of WWW applications and a tool environment specifically tailored for the methodology. The methodology and the development environment are based upon models and techniques already used in the hypermedia, information systems, and software engineering fields, adapted and blended in an original mix. The foundation of the proposal is the conceptual design of WWW applications, using HDM-lite, a notation for the specification of structure, nav ...

2 Current technological impediments to business-to-consumer electronic 88%



commerce

Gregory Rose , Huoy Khoo , Detmar W. Straub

Communications of the AIS June 1999

3 Digital library technology for locating and accessing scientific data 85%



Robert E. McGrath , Joe Futrelle , Ray Plante , Damien Guillaume

Proceedings of the fourth ACM conference on Digital libraries August 1999

4 Information gathering in the World-Wide Web: the W3QL query 85%



language and the W3QS system

David Konopnicki , Oded Shmueli

ACM Transactions on Database Systems (TODS) December 1998

Volume 23 Issue 4

The World Wide Web (WWW) is a fast growing global information resource. It contains

09/431,446

h c g e c f c

an enormous amount of information and provides access to a variety of services. Since there is no central control and very few standards of information organization or service offering, searching for information and services is a widely recognized problem. To some degree this problem is solved by "search services," also known as "indexers," such as Lycos, AltaVista, Yahoo, and others. ...

5 Information retrieval on the web

82%



Mei Kobayashi , Koichi Takeda

ACM Computing Surveys (CSUR) June 2000

Volume 32 Issue 2

In this paper we review studies of the growth of the Internet and technologies that are useful for information search and retrieval on the Web. We present data on the Internet from several different sources, e.g., current as well as projected number of users, hosts, and Web sites. Although numerical figures vary, overall trends cited by the sources are consistent and point to exponential growth in the past and in the coming decade. Hence it is not surprising that about 85% of Internet user ...

6 The evolution of the DARWIN system

82%



Joan D. Walton , Robert E. Filman , David J. Korsmeyer

Proceedings of the 2000 ACM symposium on Applied computing March 2000

7 Writing CGI Scripts in Python

82%



Michel Vanaken

Linux Journal February 1997

8 Spoken dialogue technology: enabling the conversational user interface

82%



ACM Computing Surveys (CSUR) March 2002

Volume 34 Issue 1

Spoken dialogue systems allow users to interact with computer-based applications such as databases and expert systems by using natural spoken language. The origins of spoken dialogue systems can be traced back to Artificial Intelligence research in the 1950s concerned with developing conversational interfaces. However, it is only within the last decade or so, with major advances in speech technology, that large-scale working systems have been developed and, in some cases, introduced into commerc ...

9 Greenstone: a comprehensive open-source digital library software system

82%



Ian H. Witten , Stefan J. Boddie , David Bainbridge , Rodger J. McNab

Proceedings of the fifth ACM conference on Digital libraries June 2000

This paper describes the Greenstone digital library software, a comprehensive, open-source system for the construction and presentation of information collections. Collections built with Greenstone offer effective full-text searching and metadata-based browsing facilities that are attractive and easy to use. Moreover, they are easily maintainable and can be augmented and rebuilt entirely automatically. The system is extensible: software "plugins" accommodate different document and me ...

10 Experiences in developing a typical web/database application

80%



J.-P. Rosen

Proceedings of the 2003 annual international conference on Ada: the engineering of correct and reliable software for real-time & distributed systems using ada

and related technologies December 2003

This paper describes Gesem, an application developed internally by Adalog for managing the registration to its training sessions. The application features a Web interface that uses AWS, an interface to the MySQL DBMS (over ODBC), and a local interface that uses GTK. The project explored various solutions, and identified a number of design patterns that made the development of new functionalities very straightforward. The experience gained in this project can be reused for any development in a si ...

11 Analysis of navigation behaviour in web sites integrating multiple information systems 80%



Bettina Berendt , Myra Spiliopoulou

The VLDB Journal – The International Journal on Very Large Data Bases March 2000

Volume 9 Issue 1

The analysis of web usage has mostly focused on sites composed of conventional static pages. However, huge amounts of information available in the web come from databases or other data collections and are presented to the users in the form of dynamically generated pages. The query interfaces of such sites allow the specification of many search criteria. Their generated results support navigation to pages of results combining cross-linked data from many sources. For the analysis of visitor naviga ...

12 Posters and Short Papers: SVG for navigating digital news video 80%



Michael G. Christel , Chang Huang

Proceedings of the ninth ACM international conference on Multimedia October 2001

Scalable Vector Graphics (SVG) is a language for describing two-dimensional graphics in XML, specifically vector graphic shapes, images, and text. SVG is a new World Wide Web Consortium (W3C) Candidate Recommendation as of November 2000, and this paper describes how SVG provides an ideal framework for presenting manipulable, interactive summarizations into a multimedia information repository. Specifically, we present VIBE and map SVG interfaces into a digital news video library for delivery thro ...

13 WebSplitter: a unified XML framework for multi-device collaborative Web browsing 80%



Richard Han , Veronique Perret , Mahmoud Naghshineh

Proceedings of the 2000 ACM conference on Computer supported cooperative work December 2000

December 2000

WebSplitter symbolizes the union of pervasive multi-device computing and collaborative multi-user computing. WebSplitter provides a unified XML framework that enables multi-device and multi-user Web browsing. WebSplitter splits a requested Web page and delivers the appropriate partial view of each page to each user, or more accurately to each user's set of devices. Multiple users can participate in the same browsing session, as in traditional conferencing groupware. Depending on the acc ...

14 Microsoft TerraServer: a spatial data warehouse 80%



Tom Barclay , Jim Gray , Don Slutz


ACM SIGMOD Record , Proceedings of the 2000 ACM SIGMOD international conference on Management of data May 2000

Volume 29 Issue 2

Microsoft® TerraServer stores aerial, satellite, and topographic images of the earth in


a SQL database available via the Internet. It is the world's largest online atlas, combining eight terabytes of image data from the United States Geological Survey (USGS) and SPIN-2. Internet browsers provide intuitive spatial and text interfaces to the data. Users need no special hardware, software, or knowledge to locate and browse imagery. This paper describes how terabytes of "Internet unfrie ...

15 The design and implementation of an intentional naming system 80%

 William Adjie-Winoto , Elliot Schwartz , Hari Balakrishnan , Jeremy Lilley
ACM SIGOPS Operating Systems Review , Proceedings of the seventeenth ACM symposium on Operating systems principles December 1999
 Volume 33 Issue 5


This paper presents the design and implementation of the Intentional Naming System (INS), a resource discovery and service location system for dynamic and mobile networks of devices and computers. Such environments require a naming system that is (i) expressive, to describe and make requests based on specific properties of services, (ii) responsive, to track changes due to mobility and performance, (iii) robust, to handle failures, and (iv) easily configurable. INS uses a simple language based o ...

16 Catching the boat with Strudel: experiences with a Web-site 80%

 management system
 Mary Fernández , Daniela Florescu , Jaewoo Kang , Alon Levy , Dan Suciu
ACM SIGMOD Record , Proceedings of the 1998 ACM SIGMOD international conference on Management of data June 1998
 Volume 27 Issue 2


The Strudel system applies concepts from database management systems to the process of building Web sites. Strudel's key idea is separating the management of the site's data, the creation and management of the site's structure, and the visual presentation of the site's pages. First, the site builder creates a uniform model of all data available at the site. Second, the builder uses this model to declaratively define the Web site's structure by applying a "site-definition query" ...

17 Using the WWW as the delivery mechanism for interactive, visualization- 80%

 based instructional modules (report of the ITiCSE '97 working group on visualization)


Thomas Naps , Joseph Bergin , Ricardo Jiménez-Peris , Myles F. McNally , Marta Patiño-Martínez , Viera K. Proulx , Jorma Tarhio
The supplemental proceedings of the conference on Integrating technology into computer science education: working group reports and supplemental proceedings June 1997

18 Using the WWW as the delivery mechanism for interactive, visulaization- 80%

 based instructional modules: report of the ITiCSE '97 working group on visualization

Thomas Naps , Joseph Bergin , Ricardo Jiménez-Peris , Myles F. McNally , Marta Patiño-Martínez , Viera K. Proulx , Jorma Tarhio
ACM SIGCUE Outl ok October 1997
 Volume 25 Issue 4

19 Visualization products on-demand through the Web 80%

 Suzana Djurcilov , Alex Pang

Proceedings of the third symposium on Virtual reality modeling language
February 1998

20 Online aggregation

80%



Joseph M. Hellerstein , Peter J. Haas , Helen J. Wang

ACM SIGMOD Record , Proceedings of the 1997 ACM SIGMOD international conference on Management of data June 1997

Volume 26 Issue 2

Aggregation in traditional database systems is performed in batch mode: a query is submitted, the system processes a large volume of data over a long period of time, and, eventually, the final answer is returned. This archaic approach is frustrating to users and has been abandoned in most other areas of computing. In this paper we propose a new online aggregation interface that permits users to both observe the progress of their aggregation queries and control execution on ...

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US006181838B1

(12) **United States Patent**
Knowlton

(10) Patent No.: **US 6,181,838 B1**
(45) Date of Patent: **Jan. 30, 2001**

(54) **MECHANISM FOR THE CAPTURE OF GRAPHICAL REPRESENTATIONS**

(75) Inventor: **Kenneth Charles Knowlton**,
Merrimack, NH (US)

(73) Assignee: **QuickBuy, Inc.**, Acton, MA (US)

(*) Notice: Under 35 U.S.C. 154(b), the term of this patent shall be extended for 0 days.

(21) Appl. No.: **09/302,345**

(22) Filed: **Apr. 29, 1999**

Related U.S. Application Data

(62) Division of application No. 08/814,118, filed on Mar. 10, 1997.

(51) Int. Cl.⁷ **G06K 9/54**

(52) U.S. Cl. **382/305; 382/312**

(58) Field of Search **382/305, 180, 382/199, 312, 100, 325; 707/348**

(56) **References Cited**

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5,684,999 * 11/1997 Okamoto 382/305
5,737,440 * 4/1998 Kunkler 382/175
5,848,186 * 12/1998 Wang et al. 382/180

5,940,535 * 8/1999 Huang 382/199

* cited by examiner

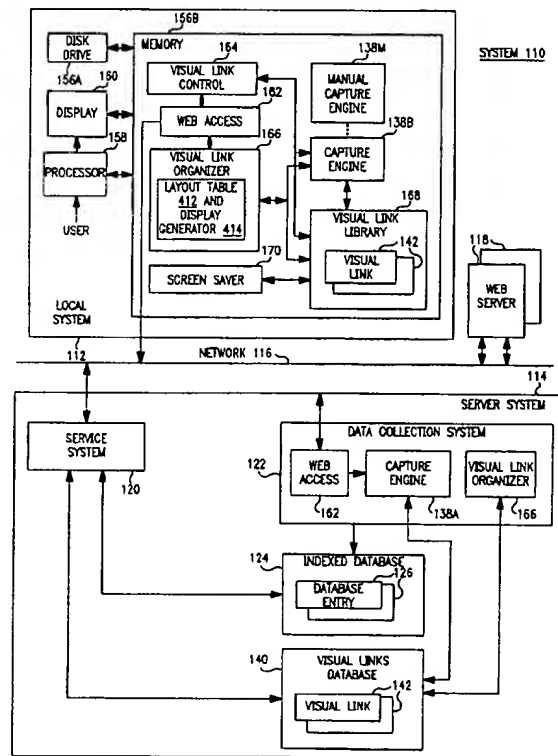
Primary Examiner—Yon J. Couso

(74) *Attorney, Agent, or Firm*—G. D. Clapp, Esq.

(57) **ABSTRACT**

A visual link mechanism residing in a local system for identifying addresses of locations in the plurality of remote systems wherein the local system is connected through a network to the plurality of remote systems. The visual link mechanism includes a visual link library and a network access mechanism responsive to a visual link including a displayable graphic icon for accessing the location represented by a selected graphic icon. Various structures of visual links are described, each being an entity existing independently of the system environment in which it resides, and the network access mechanism includes a layout table for storing a plurality of plans for arranging and displaying a plurality of visual link graphic icons in a display, a visual links organizer, a visual link screen saver, and a hash protection mechanism for detecting the unauthorized construction or modification of visual links or other forms of files. Also described is a visual link capture engine for extracting graphics information from a data file and generating a corresponding graphic icon and a display layout generator for generating display layouts of sets of predetermined numbers of displayable visual objects.

15 Claims, 17 Drawing Sheets



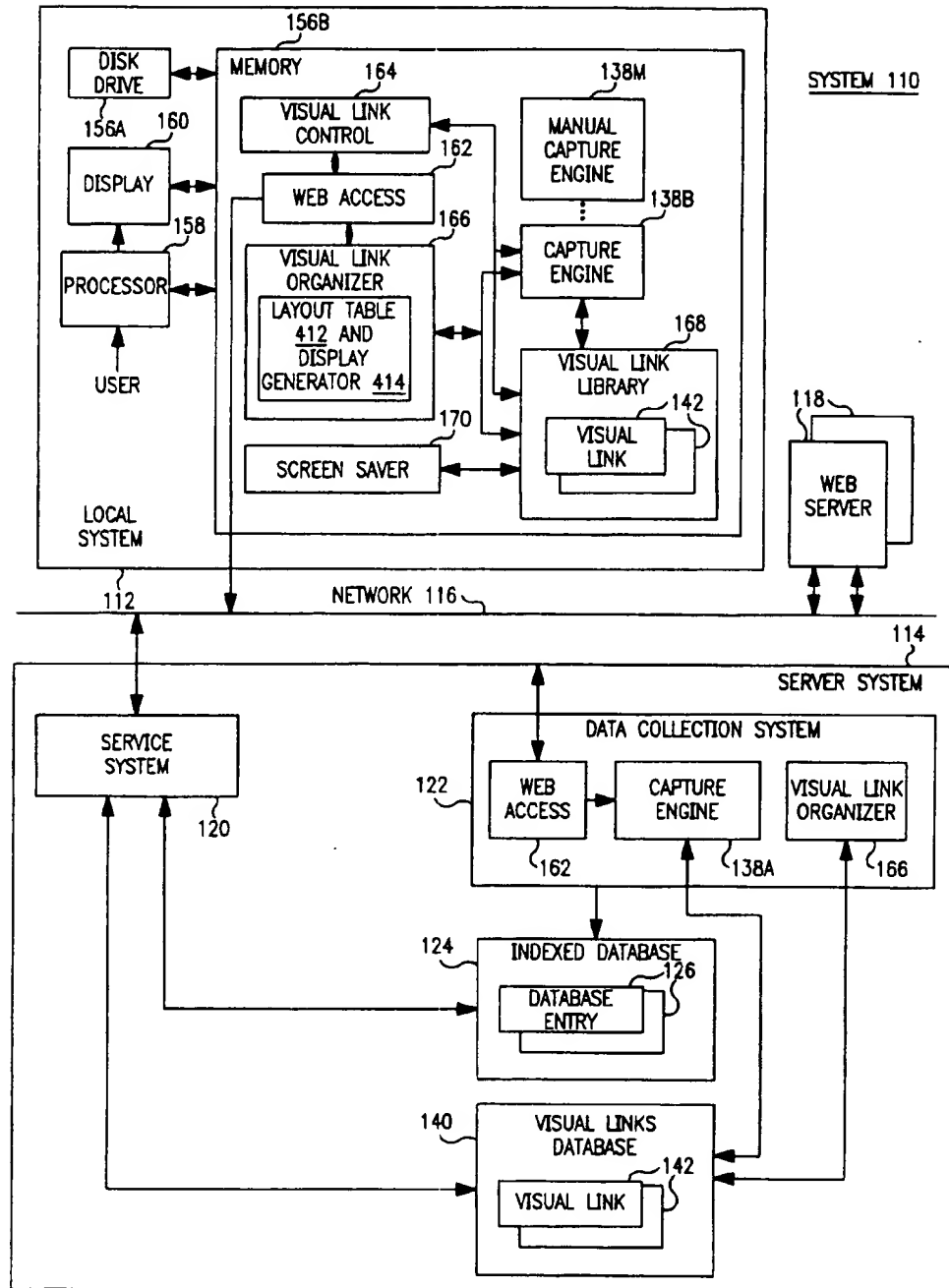


FIG. 1A

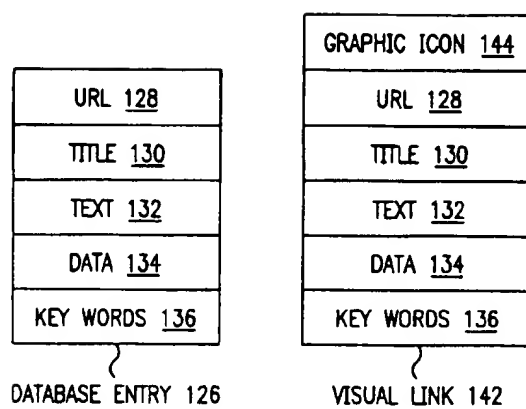


FIG. IB

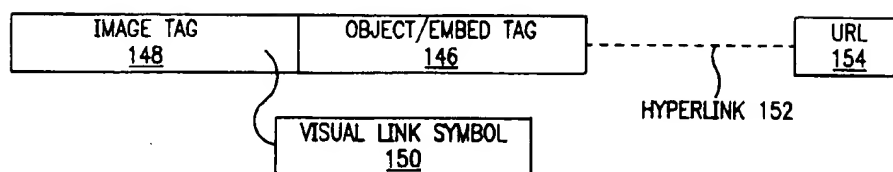


FIG. IC

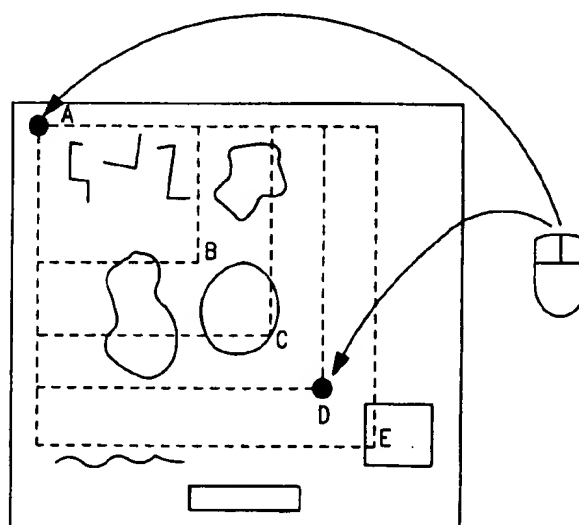


FIG. ID

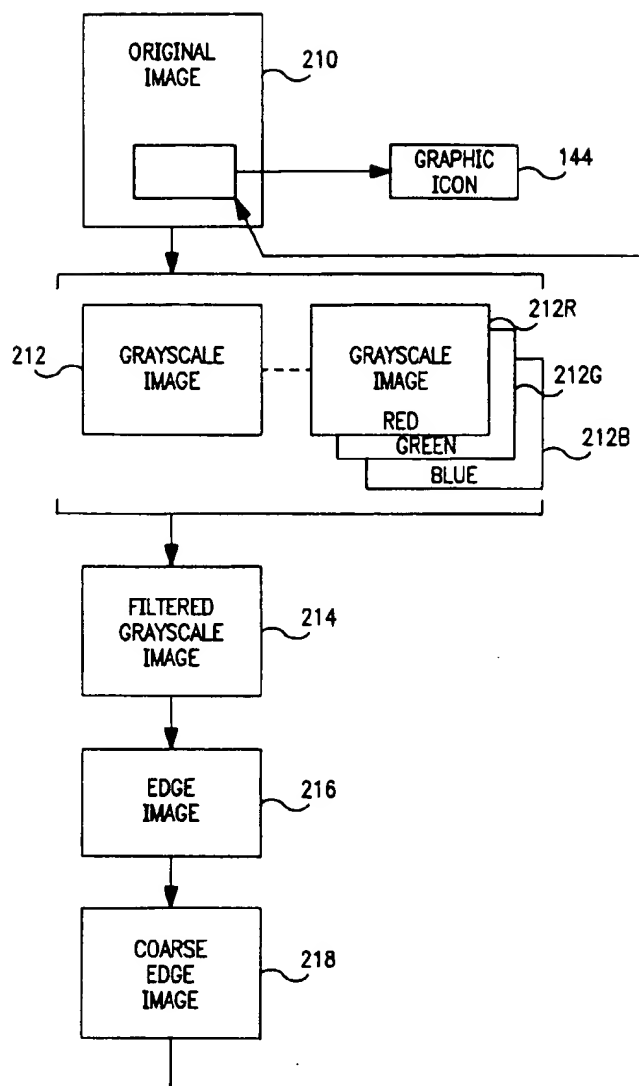


FIG. 2A

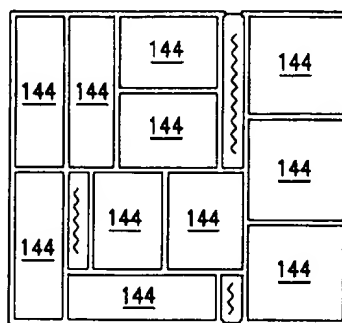


FIG. 2B

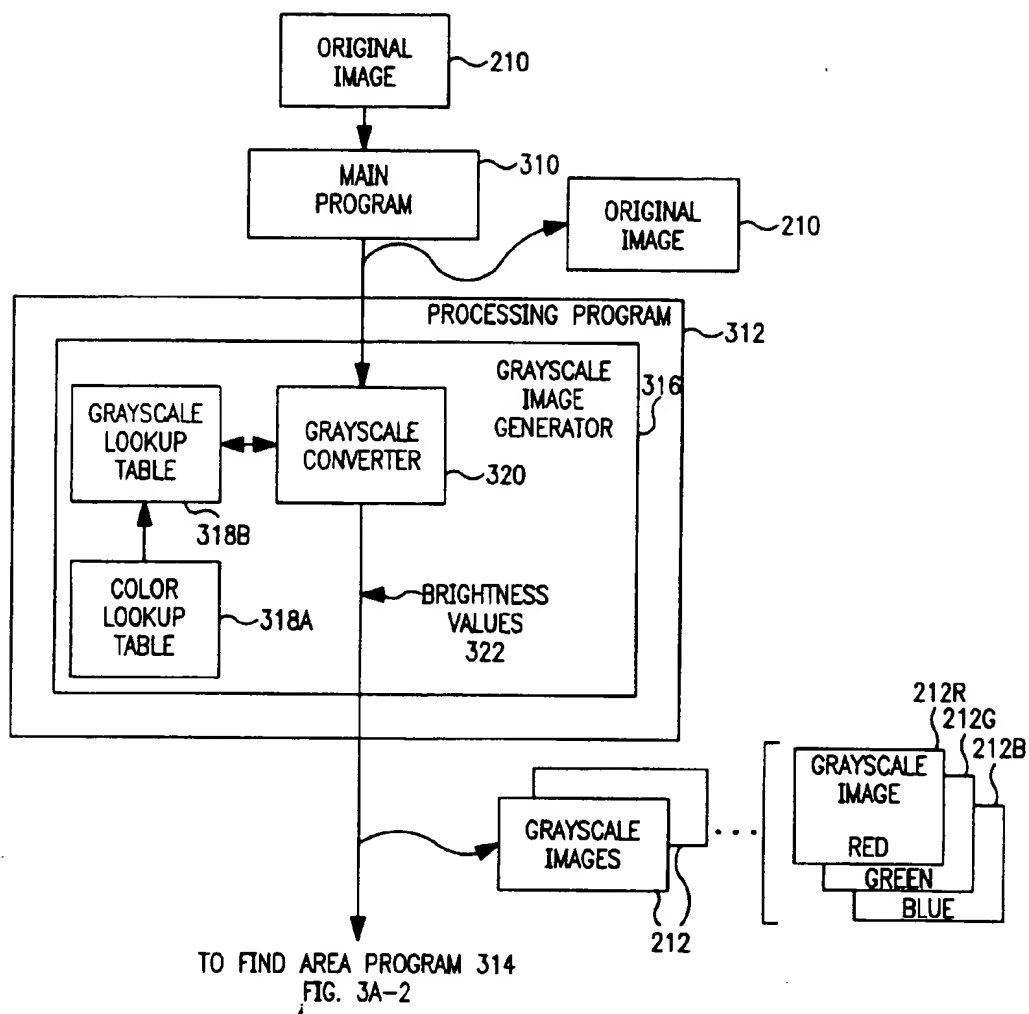


FIG. 3A-1

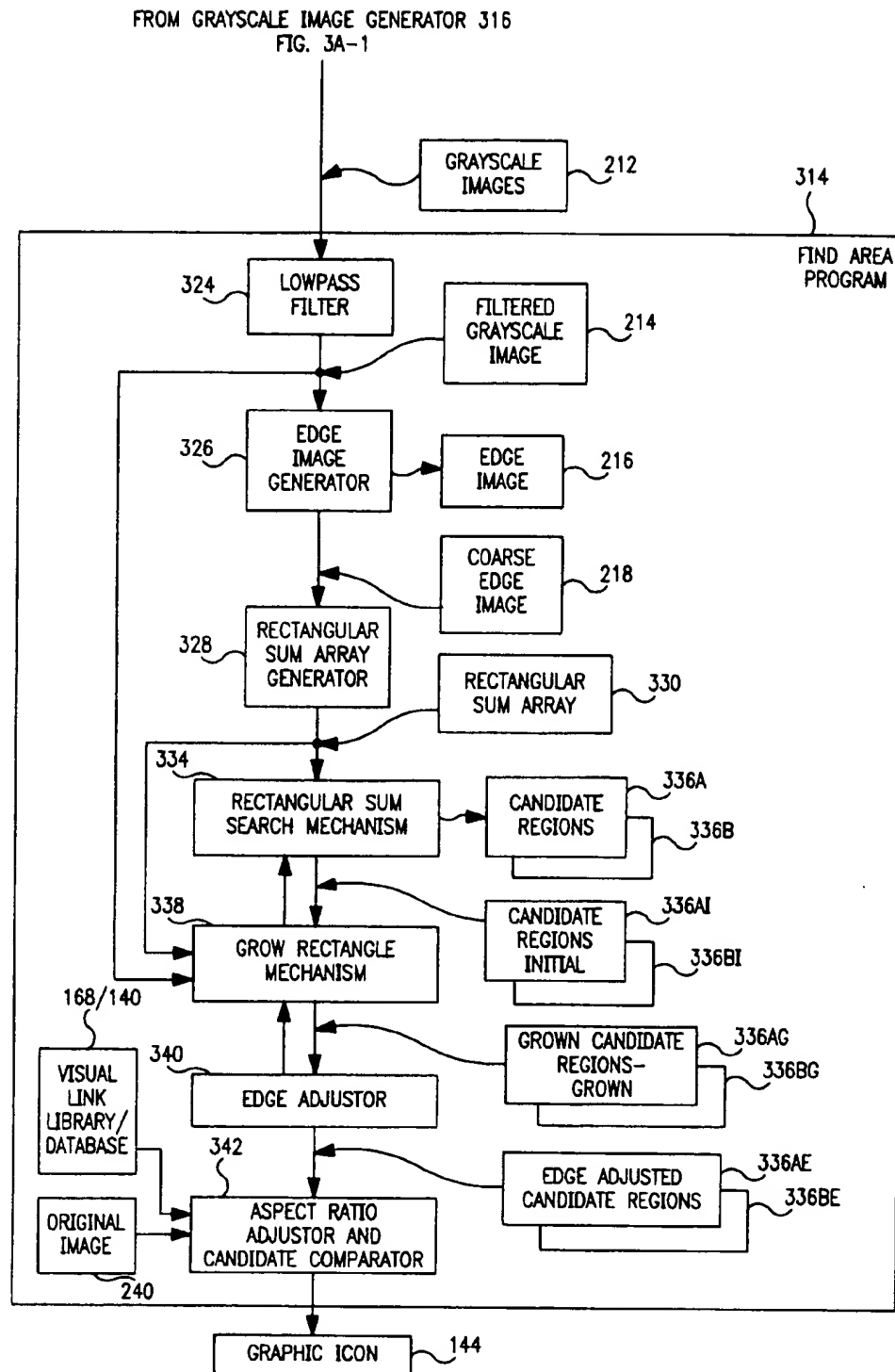


FIG. 3A-2

2-UP
1-UP
2-LEFT 1-LEFT TARGET 1-RIGHT 2-RIGHT
1-DOWN
2-DOWN

FIG. 3B

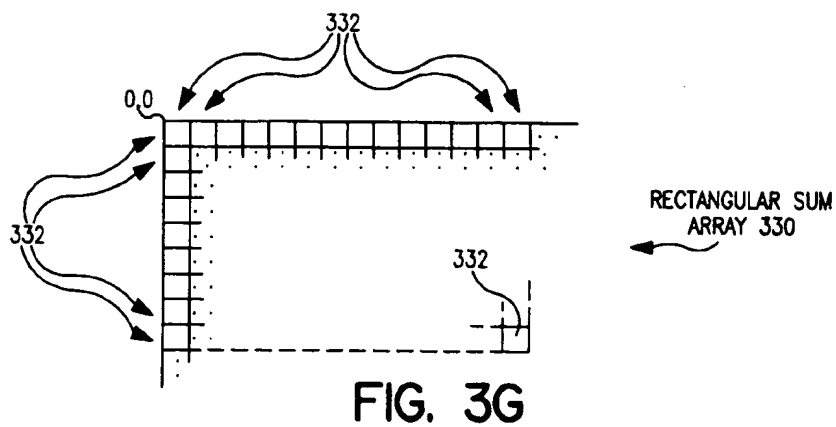
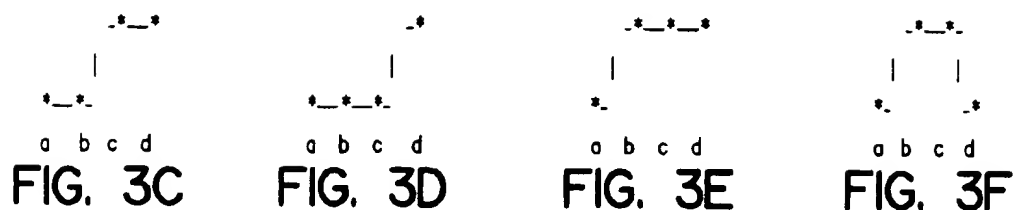


FIG. 3G

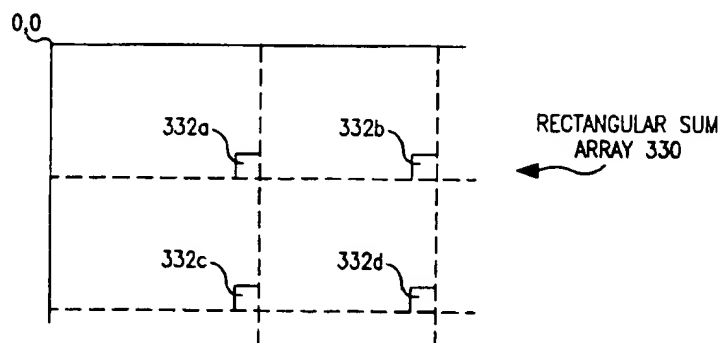


FIG. 3H

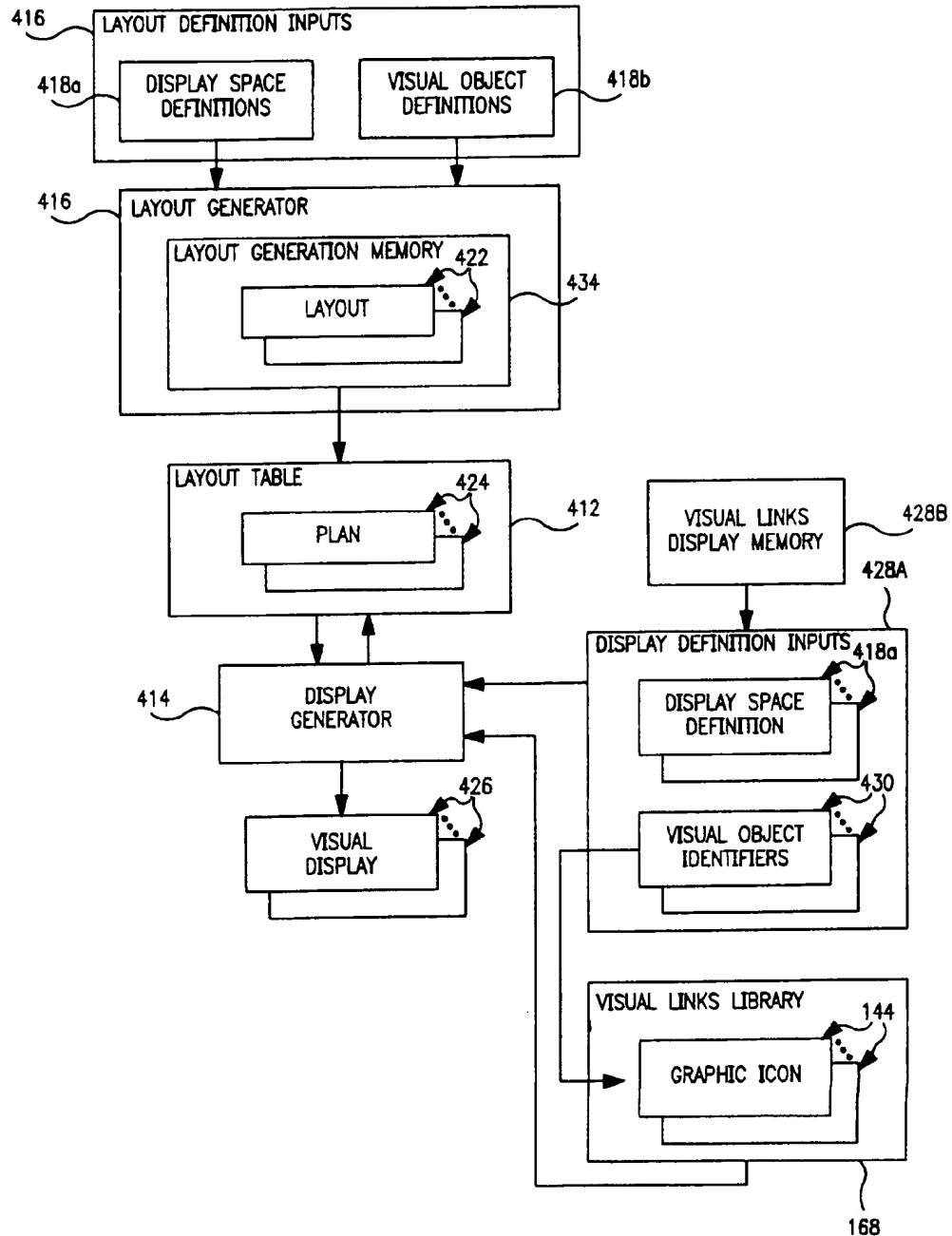


FIG. 4A

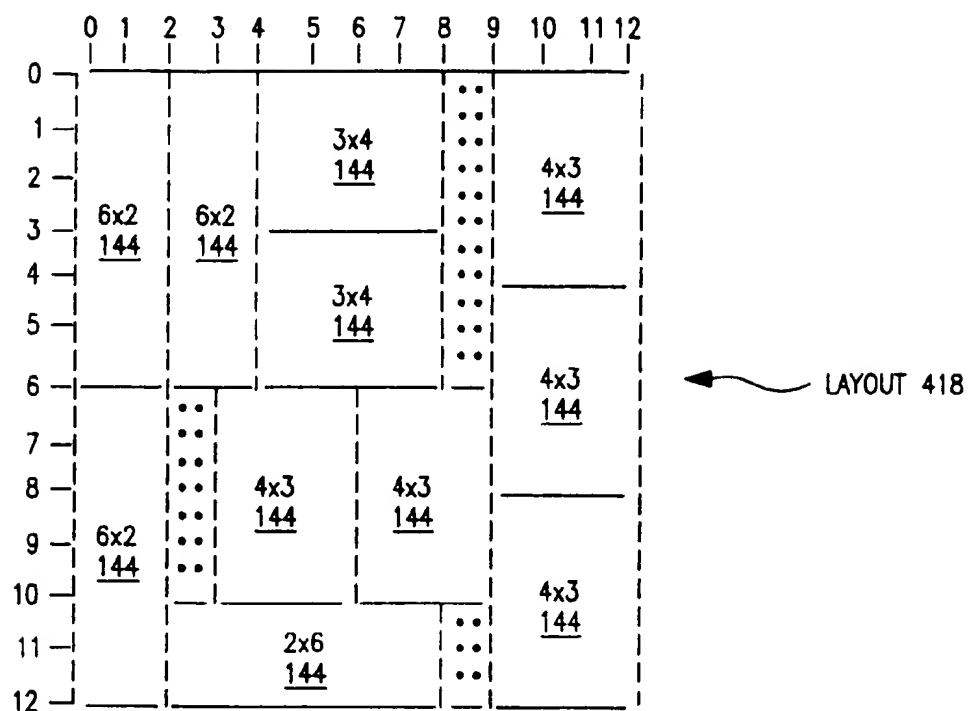


FIG. 4B

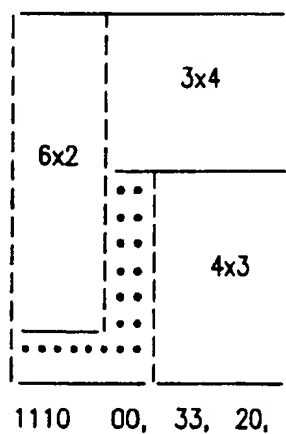


FIG. 4C

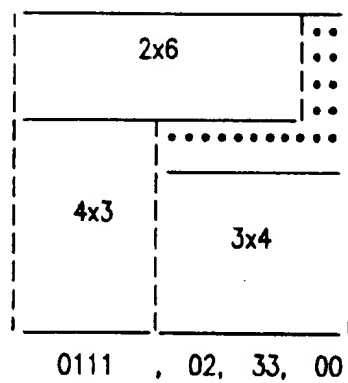


FIG. 4D

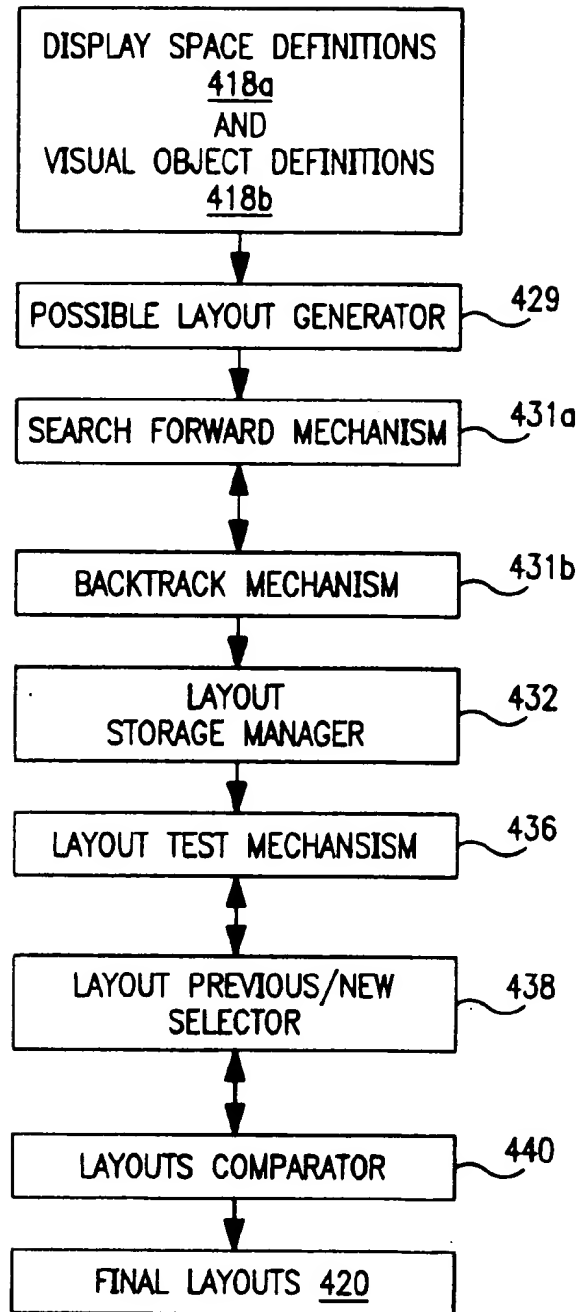


FIG. 4E-I

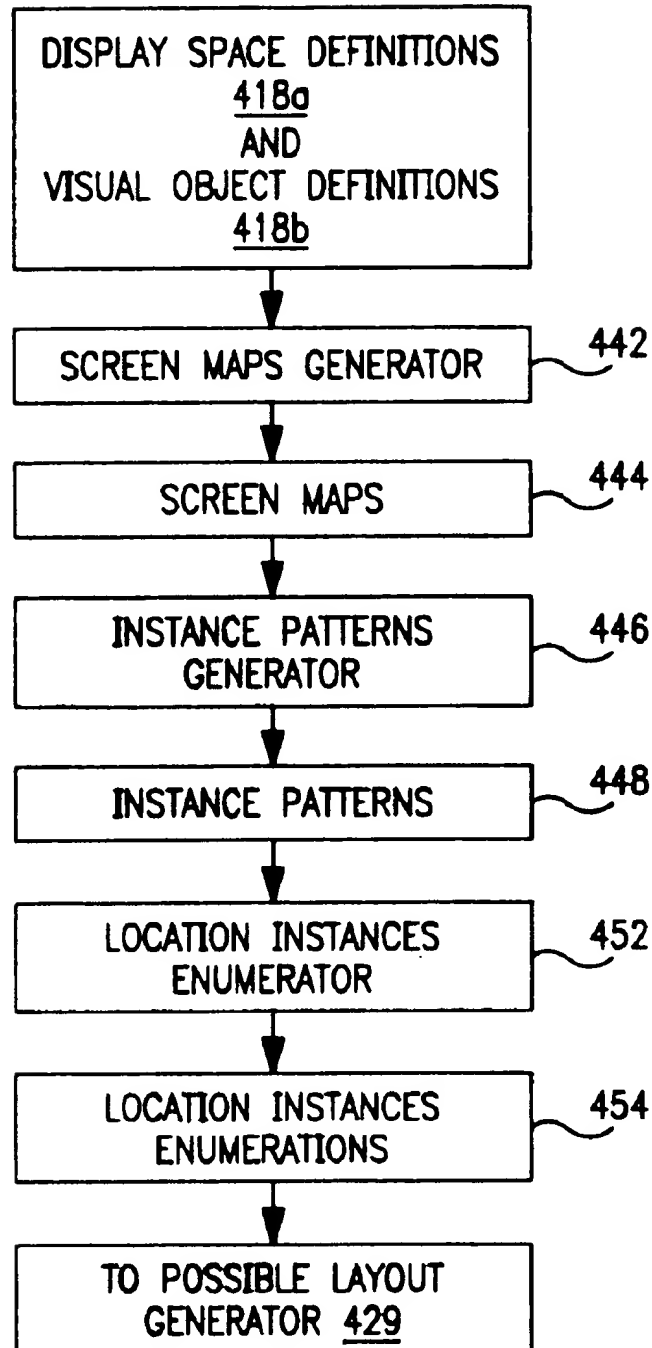


FIG. 4E-2

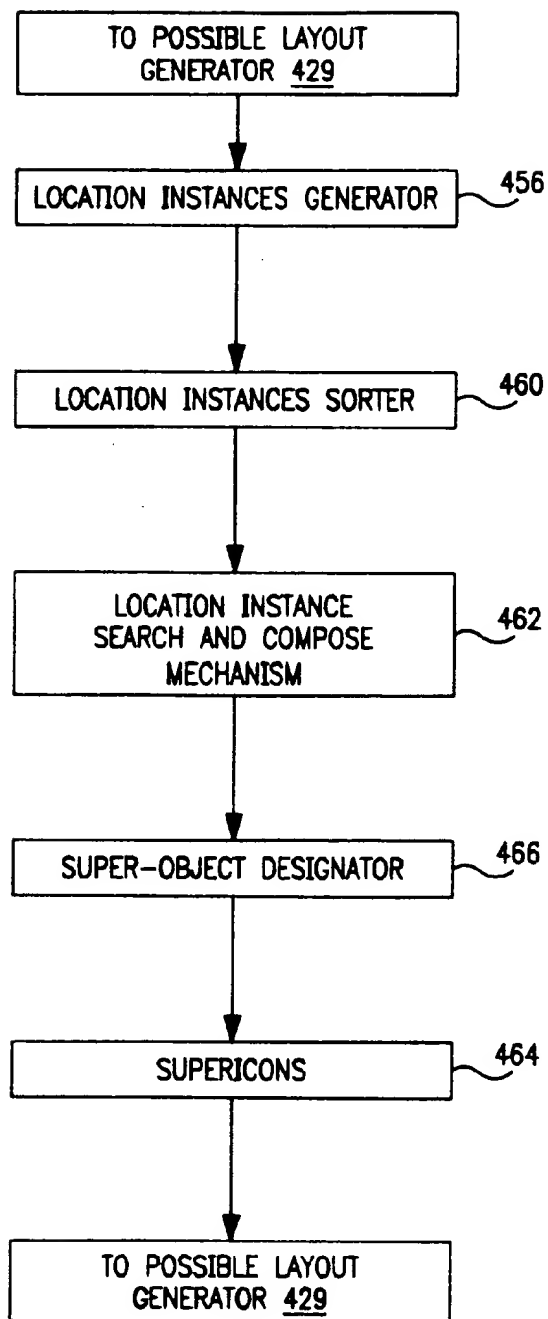


FIG. 4E-3

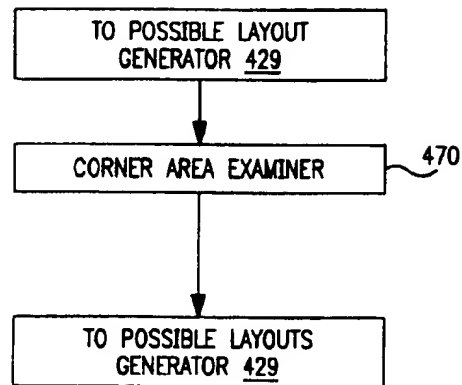


FIG. 4E-4

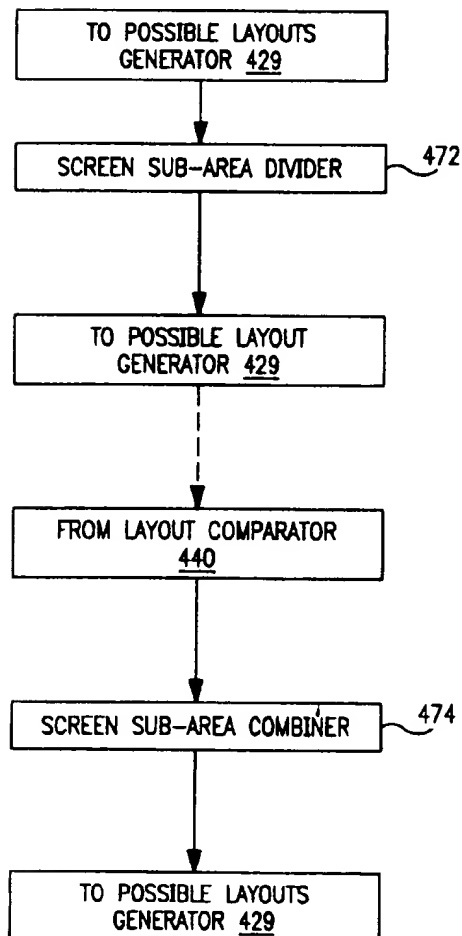


FIG. 4E-5

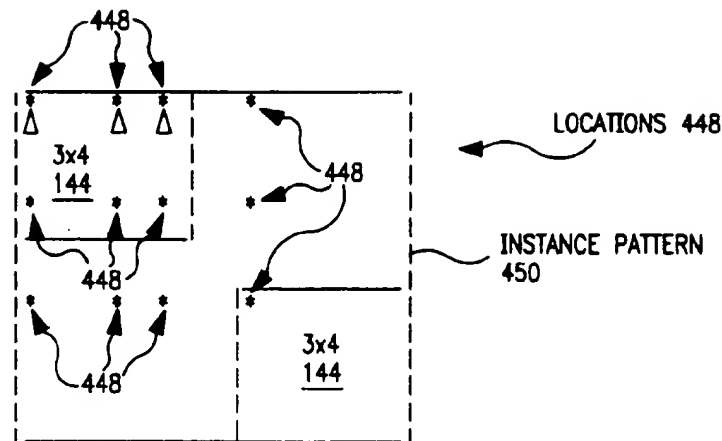


FIG. 4F

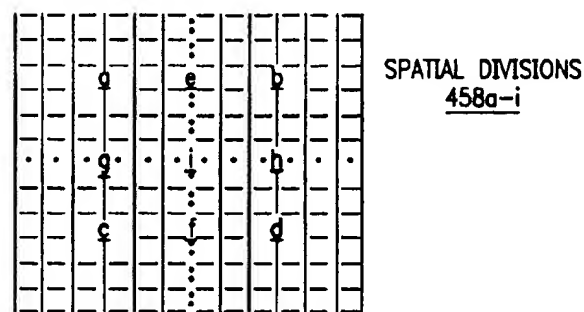


FIG. 4G

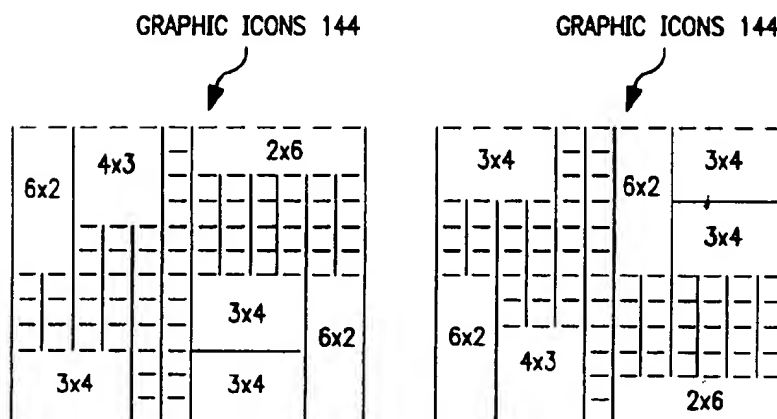


FIG. 4H

FIG. 4I

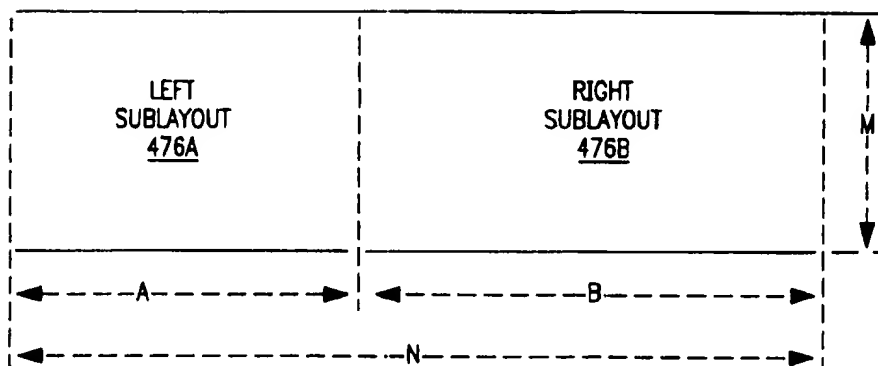


FIG. 4J

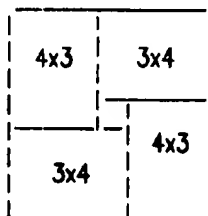


FIG. 4K

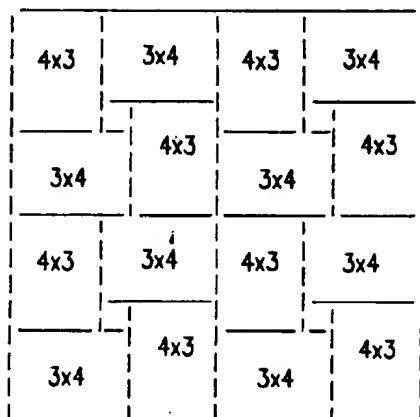


FIG. 4L

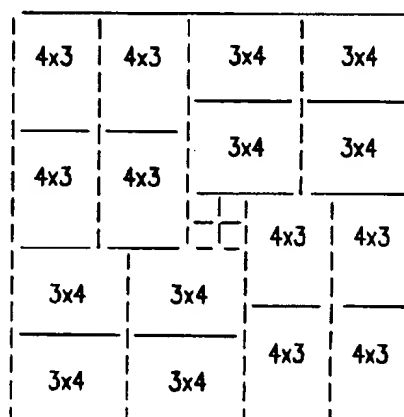


FIG. 4M

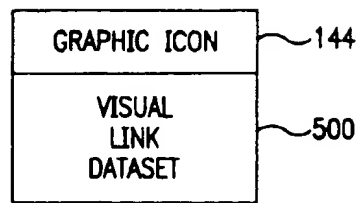


FIG. 5A

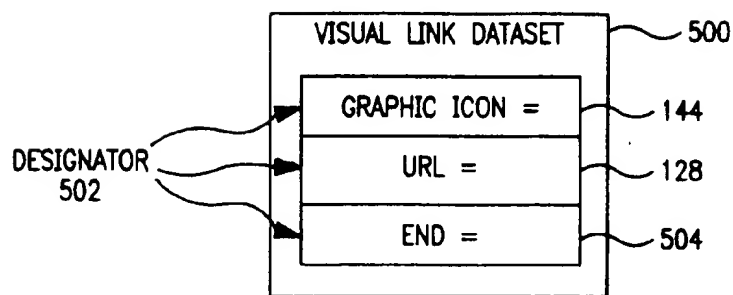


FIG. 5B

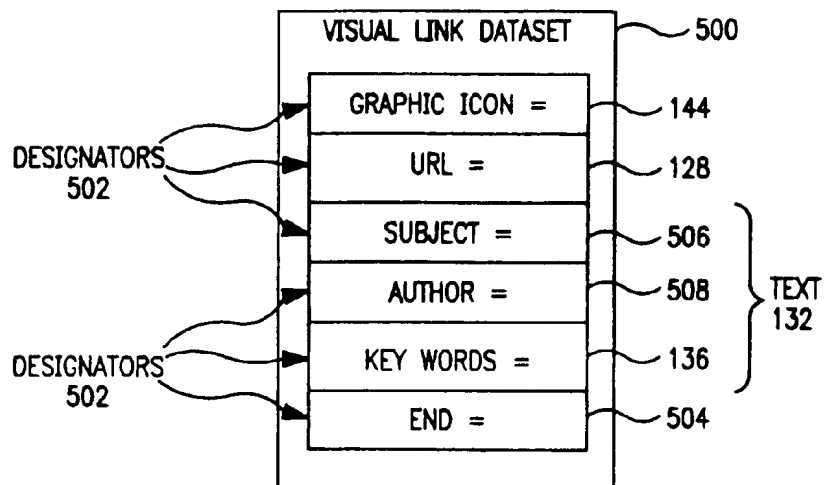


FIG. 5C

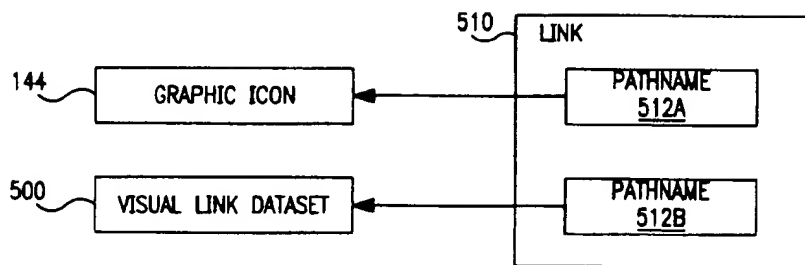


FIG. 5D

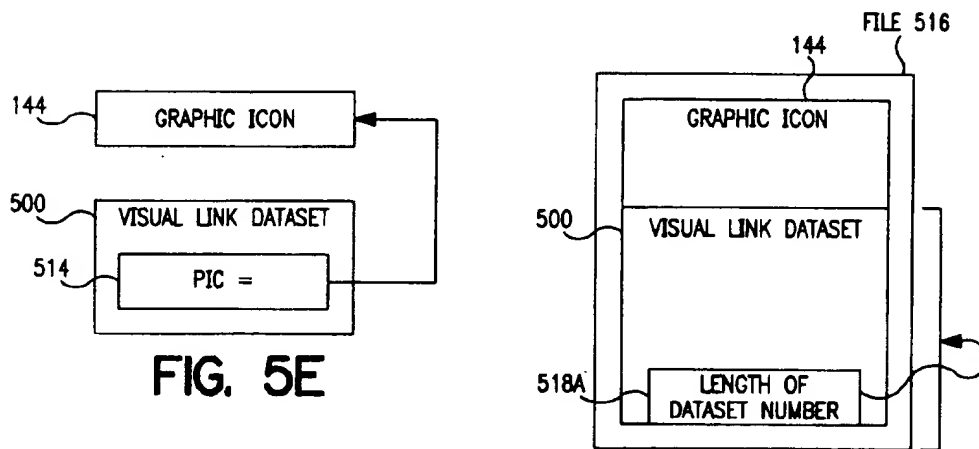


FIG. 5E

FIG. 5F

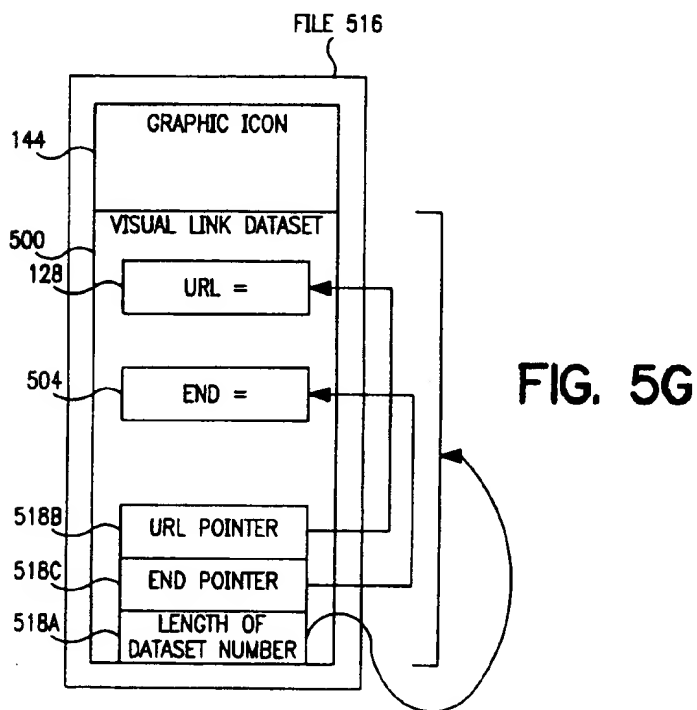


FIG. 5G

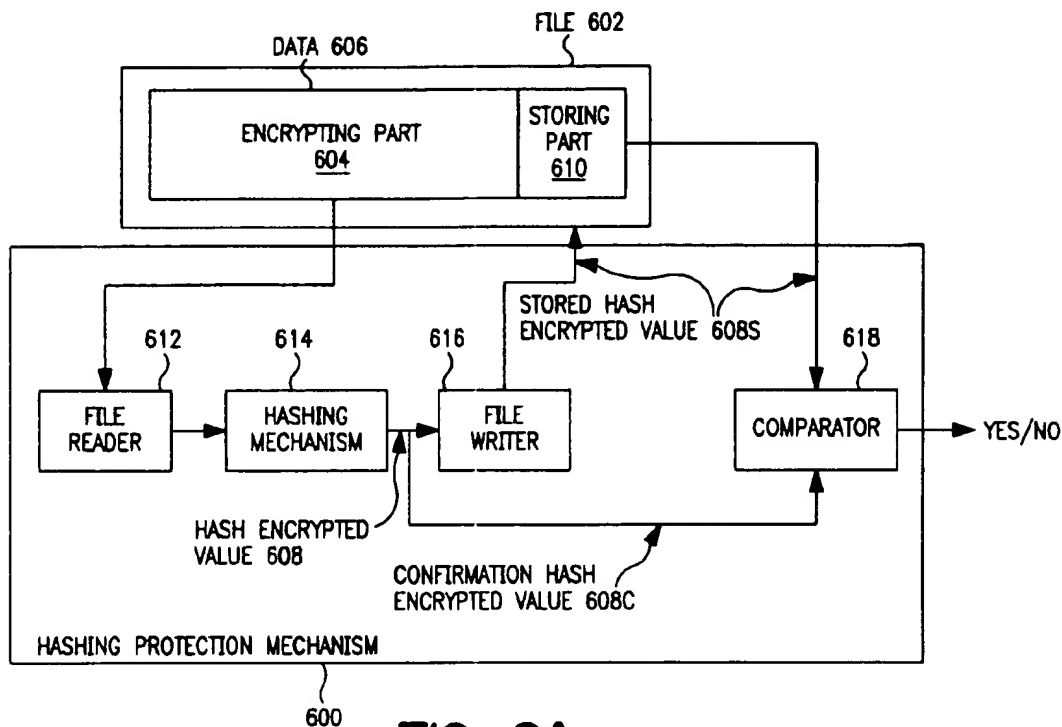


FIG. 6A

ORIGINAL FILE	HASH FILE AS PROTECTED
[vloascii]	[vloascii]
VER=1.1	1 VER=1.1
URL=http://www.foo.com	0 URL=http://www.foo.com
TTL=Welcom to FooBar	0 TTL=Welcom to FooBar
SUB=Misc. GUI stuff	1 SUB=Misc. GUI stuff
AUT=Ken Knowlton	0 AUT=Ken Knowlton
ORG=Netwave Inc.	1 ORG=Netwave Inc.
ADR=Tyngsboro MA	0 ADR=Tyngsboro MA
TEL=(509) 555-1234	1 TEL=(509) 555-1234
FAX=(508) 555-6789	0 FAX=(508) 555-6789
EML=gary@goofey.com	0 EML=gary@goofey.com
CAT=humor networks	0 CAT=humor networks
KWD=GUI browsing	1 KWD=GUI browsing
REM=an example	1 REM=an example
SEE=http://www.bar.com	1 SEE=http://www.bar.com
UID=456789	0 UID=456789
PWD=*&~%\$!@!	1 PWD=*&~%\$!@!
UDA=	0 UDA=
MIC=Boo! Click here	0 MIC=Boo! Click here
MOD=02-20-1997 19:09	1 MOD=02-20-1997 19:09
CRE=02-18-1997 17:07	0 CRE=02-18-1997 17:07
END=000391	0 END=000391

FIG. 6B-1

FIG. 6B-2

1

MECHANISM FOR THE CAPTURE OF GRAPHICAL REPRESENTATIONS

CROSS REFERENCES TO RELATED APPLICATIONS

The present Patent Application is a Divisional Patent Application of co-pending Prior patent application Ser. No. 08/814,118, filed Mar. 10, 1997 and which is incorporated herein by reference and is related to U.S. Patent Appellation Serial No. by Kenneth Charles Knowlton and Gary Steven Miliefsky for A PROTECTION MECHANISM FOR VISUAL LINK OBJECTS and to U.S. patent application Ser. No. 09/302,344 by Kenneth Charles Knowlton and Gary Steven Miliefsky for A DISPLAY LAYOUT GENERATOR FOR GRAPHICAL REPRESENTATIONS, both of which are filed on even date with the present Patent Application.

FIELD OF THE INVENTION

The present invention relates to a method and apparatus for the graphical representation of bodies or sources of information and, in particular, a method and apparatus for capturing and displaying graphic representations of bodies or sources of information and for indexing and accessing the bodies or sources of information.

BACKGROUND OF THE INVENTION

The volume of information accessible to users of computer systems, either directly on a local system or indirectly through a network, such as the internet and the World Wide Web constructed on the internet, usually referred to as "the Web", has increased to the point where tracking and indexing the information so that the user can locate a given body or source of information has become a primary problem. For example, users may have literally thousands of documents, spreadsheets, and graphics files directly available on their local system and as many universal resource locators (URLs), wherein each URL essentially points to or is an address of a location of a body or source of information on the internet and contains the information required to direct a TCP/IP based protocol executing on a system to a particular location or resource on the internet and on intranets.

The problem is compounded in that the methods and means in general use for indexing such information remains relatively primitive compared to the methods and means for generating and accessing the information.

For example, it is well known and widely accepted that humans comprehend complex or voluminous information more readily when it is presented in graphical form rather than as text or numbers. This characteristic is, in fact, widely exploited in computer operating environments such as Microsoft Windows and Apple Macintosh and in most applications programs, such as Netscape Navigator, and even in much of the information itself, which is frequently graphical in nature or uses or incorporates graphical information.

The methods presently in use for indexing information or sources of information, however, generally represent bodies or sources of information, such as files or URLs, in text form, that is, as lists of alphanumeric names or designators. For example, even the computer operating environments and applications programs providing graphical user interfaces, such as Microsoft Windows, the Apple Macintosh and Netscape Navigator, either use alphanumeric designators alone or use alphanumeric designators to distinguish between otherwise identical icons representing files generically.

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The systems of the prior art have generally retained alphanumeric designators to represent bodies or sources of information because of the difficulties inherent in representing each individual file or source of information with a graphic representation that is sufficiently distinguishable from other graphic representations of files or sources of information and that presents a visually strong image to a user.

The primary problem in this respect is the volume of data that must be stored to represent each file or source of information individually when there are potentially hundreds of such files or sources of information to individually designate. That is, it has been generally accepted in the prior art that it is necessary to have a relatively large and complex graphic representation of each file or source of information in order to have visually strong and distinguishable representations of files or sources of information when there is more than a relatively limited number of files or sources of information. As such, only a few specialized applications programs, such as the Corel graphics programs and, for example, hypertext markup language (HTML) pages, such as frequently used on the Web, have attempted to provide any form of graphically based indexing of files. These programs and HTML pages have generally used compressed versions of full size images for this purpose, which are in themselves large graphics files, thereby requiring long extensive storage space and long transmission times to transfer over a network.

Related problems are, of course, the overwhelming effort necessary to generate what may be literally hundreds of unique representations to be associated with various files and sources of data, and the inherent problems in organizing and displaying such graphic representations for files and information sources on a typical display.

Still other related problems are, for example, the detection of the unauthorized construction or modification of computer files, such as visual links, and an effective method for providing encrypted authorization within a file, again such as a visual link, without increasing the size of the file or causing difficulties for human and system readers of the file.

The present invention provides a solution to these and other problems of the prior art.

SUMMARY OF THE INVENTION

The present invention is directed to a visual link mechanism residing in a local system for identifying addresses of locations in the plurality of remote systems wherein the local system is connected through a network to a plurality of remote systems and typically includes a memory for storing data and programs, a processor operating under control of the programs to perform operations on the data, and a display.

According to the present invention, the visual link mechanism includes a visual link library for storing visual links wherein each visual link corresponds to an address of a location in the plurality of remote systems, and a network access mechanism connected to the network for displaying the visual links to a user and allowing the user to select a visual link representing a corresponding location in a remote system. The network access mechanism is responsive to the visual link selected by the user for accessing the location represented by the selected visual link, and each visual link includes a graphic icon providing a displayable image representing the corresponding location and the address of the corresponding location.

Each visual link may also include alphanumeric information relating to the corresponding location, including a title

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identifying the location and text describing the location, and may include keywords relating to the contents of the location.

Each visual link preferably may include the graphic icon providing a displayable image representing the corresponding location and a visual link dataset containing information relating to the location, including the address of the corresponding location, wherein each visual link dataset may include a plurality of designators, each designator storing corresponding information relating to the corresponding location and including a graphic icon designator for storing an identification of the corresponding graphic icon, an address designator for storing the address of the corresponding location, and an end designator for indicating the end of the visual link dataset.

The designators may further include a subject designator for storing text information identifying the contents of the location, an author designator for storing text information identifying the author of the contents of the location, and a keyword designator for storing key words relating to the contents of the location.

According to the present invention, the visual link mechanism further includes a link for relating the graphic icon and the visual link dataset. In one implementation, the link comprises a file for storing a pathname of the graphic icon and a pathname of the visual link dataset and in another the link comprises a graphic icon pointer designator stored in the visual link dataset for storing an identification of the graphic icon. In still other implementations, the graphic icon and the visual link dataset are stored in a single file, the graphic icon being stored starting at the beginning of the file and the visual link dataset following the graphic icon, wherein the visual link dataset further includes a length of dataset number stored at the end of the file and indicating the location of the start of the visual link dataset relative to the end of the file. In yet other implementations, the visual link dataset further includes an address pointer and an end pointer stored preceding the length of dataset number and indicating the locations of the address designator and the end designator in the file.

Further according to the present invention, the network access mechanism includes a layout table for storing a plurality of plans for arranging and displaying a plurality of graphic icons in display spaces wherein each plan corresponds to a display space of predetermined dimensions and to a predetermined number of graphic icons of predetermined dimensions and defining the arrangement of the graphic icons in the display space, a input for providing a set of display definition inputs wherein each set of display definition inputs includes a display space definition identifying the dimensions of a display space and a set of visual object definitions identifying a set of graphic icons of a predetermined number and of predetermined dimensions to be displayed in the display space. A display generator is responsive to the display definition inputs for reading from the layout memory a plan corresponding to a set of display definition inputs and generating a display of the identified set of graphic icons in the display space according to the corresponding plan and displaying the identified set of graphic icons on the display. In one implementation, the input for providing a set of display definition inputs includes a visual link display memory for storing groups of identifications of visual links, each group of identifications of visual links being a set of visual object definitions identifying a set of graphic icons of a predetermined number and of predetermined dimensions to be displayed in the display space.

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Still further according to the present invention, the network access mechanism includes a visual links organizer connected to the display for displaying the visual links to a user and allowing the user to select a visual link representing a corresponding location in a remote system and a network communication mechanism connected to the visual links organizer and responsive to the visual link selected by the user for accessing the location represented by the selected visual link.

The visual link mechanism of the present invention may also include a visual link screen saver connected from the visual link library and to the display and responsive to operations of the local system for generating a visual link screen saver display of selected graphic icons on the display wherein the screen saver is responsive to an indication of a displayed graphic icon of the visual link screen saver display for invoking the a network access mechanism for accessing the location represented by the selected visual link corresponding to the selected graphic icon.

In other aspects, the present invention includes a hash protection mechanism for detecting the unauthorized construction or modification of visual links or other forms of files, including a file reader for reading an encryption part of a file and a stored hash encryption value stored in a storing part of the file, a hashing mechanism for generating an encrypted hash value from the data contained in the encryption part of the file, and a comparator for comparing the generated encrypted hash value and the stored hash value and determining when the generated and stored hash values are equal. According to the present invention, the storing part of the file includes data of the file separate from the encrypting part of the data of the file and the data of the storing part of the file is characterized in having alternate and semantically equivalent expressions wherein the stored hash encryption value is encoded in the data of the storing part of the file using the alternate and semantically equivalent expressions representing the data of the storing part of the file to encode the stored hash encryption value.

The present invention also includes a capture engine for extracting graphics information from a data file and generating a corresponding graphic icon forming a displayable image representing the graphics information. According to the present invention, the capture engine includes a grayscale image generator for receiving an original image and generating a corresponding grayscale image containing brightness values representing the original image, an edge image mechanism for receiving the grayscale image and generating a corresponding edge image representing areas of visually significant graphic structure in the grayscale image as represented by areas of change in the brightness values, a candidate region search mechanism for receiving the edge image and identifying initial candidate regions of the edge image representing visually significant areas of the original image, and a candidate region adjustment and comparator mechanism for selecting a candidate region to be used in generating a corresponding graphic icon and for adjusting the selected candidate region to conform to predetermined dimensions for a graphic icon.

In further aspects of the present invention, the grayscale image generator includes a grayscale lookup table for storing grayscale brightness values corresponding to each of the possible brightness values of image elements in original images, a grayscale converter for reading the brightness values of the image elements of the original image, reading the corresponding grayscale brightness values stored in the grayscale lookup table, and generating a corresponding grayscale image wherein each image element of the original

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image is represented by a grayscale image element having the grayscale brightness value corresponding to the brightness value of the image element.

Also according to the present invention, each image element of the original image is represented by a set of color values, the set of color values of an image element of the original element representing the color and brightness value of the image element. Accordingly, the grayscale lookup table contains a grayscale brightness value corresponding to each of the possible sets of color values of image elements in original images and the grayscale converter is responsive to the set of color values of each image element of the original image for reading the corresponding grayscale brightness values stored in the grayscale lookup table and generating a corresponding grayscale image wherein each image element of the original image is represented by a grayscale image element having the grayscale brightness value corresponding to the set of color values of the image element.

Also, the grayscale image generator generates each image element of the grayscale image from a plurality of corresponding elements of the original image so that the number of image elements in the grayscale image is proportionally reduced from the number of image elements in the corresponding original image.

According to the present invention, the edge image mechanism includes an edge image generator for receiving an input grayscale image and generating a corresponding output edge image wherein each image element of an output edge image is represented by an edge value proportionate to the difference between the brightness value of the corresponding image element in the input grayscale image and the brightness values of the neighboring image elements of the corresponding image element in the input grayscale image. An output edge image thereby represents areas of visually significant graphic structure in the input grayscale image as represented by areas of change in the brightness values of the input grayscale image.

The edge image mechanism may also include a lowpass filter connected between the grayscale image generator and the edge image generator for receiving a grayscale image and generating a corresponding filtered grayscale image of reduced resolution and provides the filtered grayscale image to the edge image generator as the correspond input grayscale image to the edge image generator, wherein each image element of a filtered grayscale image is determined as a proportioned summation of the brightness values of selected neighboring image elements of the image element of the grayscale image so that a filtered grayscale image thereby represents visual structures of significant extents of the grayscale image.

In further aspects of the present invention, the edge image generator generates each image element of an output edge image from a plurality of corresponding elements of the input grayscale image so that the number of image elements in the output edge image is proportionally reduced from the number of image elements in the corresponding grayscale input image.

Still further according to the present invention, the candidate region search mechanism includes a rectangular sum array generator for receiving an output edge image and generating a corresponding rectangular sum array having a sum element corresponding to each image element of the output edge image wherein each sum element represents the sum of the edge values of the image elements of a region of the output edge image bounded by a coordinate location of

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the output edge image and the output edge image element corresponding to the sum element. A rectangular sum search mechanism is connected from the rectangular sum array generator to receive the rectangular sum array for examining the summed edge values represented in each of the sum elements of the rectangular sum array and identifying at least one initial candidate region having a high summed edge value, each initial candidate region thereby representing and corresponding to a region of the original image having a significant visual structure.

Still further, the candidate region adjustment and comparator mechanism includes an edge adjuster for receiving the at least one initial candidate region and generating from each initial candidate region a corresponding grown candidate region by adjusting the extents of each initial candidate region to include all portions of significant visual structures having a part thereof contained within the initial candidate region, generating from each grown candidate region a corresponding edge adjusted candidate region by adjusting the extents of each grown candidate region so that each edge adjusted candidate region conforms to one of a set of predetermined extents for graphic icons, comparing each edge adjusted candidate region with others of the edge adjusted candidate regions and selecting the edge adjusted candidate region having the highest amount of significant visual structure, and comparing each selected edge adjusted candidate region with previously existing graphic icons. When the selected edge adjusted candidate region is similar to a previously existing graphic icon, the edge adjuster selects a next one of the at least one edge adjusted candidate regions, and, when a selected candidate region is distinguished from the previously existing graphic icons, identifies the corresponding region of the original image for use as a graphic icon.

The present invention also provides a display layout generator for generating layouts of sets of predetermined numbers of displayable visual objects of predetermined dimensions into a display area of predetermined dimensions. According to the present invention, the display layout generator includes a possible layouts generator for receiving a display space definition defining the dimensions of the display area and a visual object definition defining the numbers and dimensions of the visual objects to be arranged in the display area and generating all possible layouts of the visual objects in the display area by placing in a layout a visual object and searching forward with a next visual object to identify a placement of the next visual object and backtracking on each next placed visual object by removing the next placed visual object and selecting and placing a different next visual object until all combinations of visual objects and placements of visual objects have been exhausted.

The display layout generator further includes a layout memory for storing each arrangement of the set of visual objects in the display area generated by the possible layouts generator, a layout test mechanism for testing each new layout by comparing each new layout with previously existing layouts to determine when the new layout has a subpopulation of a previously existing layout or matches a previously existing layout and when the previously existing layout has a subpopulation of the new layout, wherein a subpopulation is a subset of the visual objects, a layout previous/next selector for selecting the new layout or the previously existing layout by discarding the new layout when the new layout has a subpopulation of a previously existing layout or matches a previously existing layout and replacing the previously existing layout with the new layout when the previously existing layout has a subpopulation of

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the new layout, a layouts comparator for comparing pairs of layouts stored in the layout generator memory and discarding any layout that contains a subpopulation of another layout, and a layout table for storing the final layouts for use in generating visual displays of the sets of visual objects in the display areas.

According to the present invention, the layout generator may further include a screen map generator for receiving the display space definition and the visual object definition and generating a screen map corresponding to the defined display area and having instance locations representing possible placement locations of the visual objects in the display area, an instance pattern generator for receiving the screen map and the visual object definition and generating, for each type of visual object of the set of visual objects wherein a type of visual object is defined by the dimensions of a visual object, at least one instance pattern representing all possible instances of locations of the visual object in the screen map, and an instance pattern enumerator for enumerating the resulting instance patterns and providing the enumerated instance patterns to the possible layouts generator to be used as initial starting points in generating layouts.

The layout generator may further include a screen spatial division generator connected from the possible layouts generator for receiving the display space definition and the enumerated instances patterns and dividing the defined display area into spatial divisions along axes of symmetry, a location instances sorter for sorting, for each spatial division of the display area, the enumerated instance patterns of visual objects in each spatial division by visual object type, and generating a set of location instances of visual objects for each spatial division, a location instance search and compose mechanism for searching for and generating, from the sets of location instances of visual objects for each spatial division, at least one combination of location instances in at least one spatial division wherein each combination of location instances contains a combination of visual objects of the set of visual objects, and a super-object generator for designating each combination of visual objects as a visual super-object and providing the designations to the possible layouts generator as representing corresponding visual object.

The layout generator may also include a corner area examiner connected from the possible layouts generator for receiving the layouts and examining the corner areas of the layouts for unique combinations of visual objects and discarding layouts having corner areas having layouts of visual objects that are rotational or reflectional equivalents of a previously existing layout.

Finally, the layout generator may also include a screen sub-area divider connected from the possible layouts generator for receiving the display area definition and dividing the display area into sub-areas and provide to the possible layouts generator a display space definition for each sub-area for use in generating layouts for each sub-area and a screen sub-area combiner connected from the layout comparator for composing layouts for the display area by combining the layouts for the sub-areas and provide the combined layouts to the layout comparator as the layout for the defined display area.

DESCRIPTION OF THE DRAWINGS

The foregoing and other objects, features and advantages of the present invention will be apparent from the following description of the invention and embodiments thereof, as illustrated in the accompanying figures, wherein:

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FIG. 1A is a block diagram of a system embodying the present invention;

FIG. 1B is diagrammatic representations of a database entry and a visual link;

FIG. 1C illustrates the embedding of a visual link reference in a hypertext document;

FIG. 1D illustrates the designation of an area of a hypertext document to comprise a graphic icon;

FIG. 2A is a diagrammatic representation of the image data structures generated and used in capturing a graphic icon;

FIG. 2B illustrates the arrangement or tiling of graphic icons with borders in a display;

FIGS. 3A-1 and 3A-2 are block diagrams of a capture engine of the present invention;

FIGS. 3B, 3C, 3D, 3E and 3F are diagrammatic representations of scaling and edge determination performed by the capture engine of the present invention;

FIGS. 3G and 3H illustrate the use of a rectangular sum array to determine area content by the capture engine of the present invention;

FIG. 4A is a block diagram of a visual links organizer for generating display layouts and plans for graphic icons;

FIGS. 4B, 4C and 4D are illustrations of graphic icon layouts and plans;

FIGS. 4E-1 through 4E-5 are block diagrams illustrating the generation of graphic icon layouts and plans by the visual links organizer;

FIGS. 4F, 4G, 4H, 4I, 4J, 4K, 4L, and 4M are illustrations of data structures and layouts used in the operation of the visual links organizer in generating graphic icon layouts and plans;

FIGS. 5A through 5G illustrate embodiments of visual links according to the present invention; and,

FIGS. 6A and 6B illustrate a hashing protection mechanism for detecting the unauthorized construction or modification of a file such as a visual link.

DESCRIPTION OF THE INVENTION

As described above, the present invention is a system and a method and apparatus for the graphical representation of bodies or sources of information, such as files or internet or Web locations, and, in particular, for capturing and displaying graphic representations of the bodies or sources of information for use in indexing and accessing the bodies or sources of information. The following will first describe a presently preferred embodiment of a system for indexing and displaying and accessing information on the World Wide Web, hereafter referred to as the Web, and will then describe components of that system for capturing and displaying graphic representations of bodies of information, such as files, or sources of information, such as sites or HTML documents, on the Web and the use of such graphical representations to access such bodies or sources of information. It will be appreciated by those of ordinary skill in the arts, however, that the present system for indexing and displaying and accessing information accessible across or through a network is not limited to the World Wide Web and HTML documents residing therein, but is also applicable for indexing and displaying and accessing information accessible across or through other forms of networks, such as electronic mail systems, wherein a location on such a network is identified by some form of pointer or address and wherein locations, files or persons on such a network are

visually identifiable to a user, for example, by means of a representative graphic icon or, in an electronic mail system, a photograph of a recipient. The following descriptions, however, will focus on exemplary embodiments of the present invention as implemented for use on World Wide Web systems as representative of all generally similar types of networks wherein users wish to identify, index and access locations, files or persons on the networks.

Finally, it will be noted that in the following each reference number is a three or four digit number comprised of two rightmost digits and one or two leftmost digits wherein the one or two leftmost digits refer to the number of the figure in which the referred to element first appears while the right two digits identify the element within the figure in which the element first appears. Once assigned, a given reference number is used throughout the subsequent figures and descriptions to refer to the corresponding element.

It will also be noted that closely related figures, that is, figures illustrating related discussions in the following description, are indicated as a group of related figures by assigning a figure number to the group of figures and distinguishing among the figures of a group by alphabetic suffixes, such as FIG. 1A, FIG. 1B, and so on. In addition, certain figures are contained on multiple drawings and, in such instances, the individual drawings comprising the figures and the portions of the figures appearing thereupon are indicated and referred to by a figure number with an appended drawing number; for example, a FIG. 3A may be related to FIGS. 3B and 3C and may be comprised of three drawings identified as FIG. 3A-1, FIG. 3A-2 and FIG. 3A-3. In a similar manner, certain figures may be optionally combined with other figures, for example, to illustrate alternate or expanded embodiments of the subject matter illustrated in a first figure, and in these instances the figures are again identified by a figure number with an appended drawing number, so that a mechanism illustrated in a FIG. 4E-1 may be extended or expanded by additional components or mechanisms illustrated in FIGS. 4E-2, 4E-3, and so on.

A. DESCRIPTION OF A PREFERRED EMBODIMENT OF THE INVENTION

1. Description of a System 110 for Capturing and Displaying Bodies and Sources of Information, and Accessing the Information (FIGS. 1A, 1B, 1C and 1D)

Referring to FIG. 1A, therein is shown a block diagram of a System 110 incorporating the present invention. The System 110 is illustrated therein as having a Local System 112 connected to a Server System 114 through a Network 116. In the present discussion, and for purposes of illustration of an embodiment of the present invention, Network 116 is the internet and, in particular, the World Wide Web (Web) implemented on the internet, and Server System 114 is a World Wide Web server while Local System 112 and Server System 114 communicate with one another and with other Web Servers 118 through an appropriate communications protocol, such as TCP/IP.

Referring first to Server System 114, as shown in FIG. 1A Server System 114 includes a Network Service System 120 for communicating with Local System 112 and Web Servers 118 and a Network Data Collector and Indexing Server 122, such as a Web "Spider", for automatically searching Network 116 to locate Web Servers 118 and to access, capture and retrieve information stored on Web Servers 118, such as

in HTML documents or other forms of files. As is well known in the relevant arts, Network Data Collector and Indexing Server 122 operates to construct an Indexed Database 124 containing the information retrieved from Web Servers 118 wherein the retrieved information, is represented in FIG. 1A as stored in Database Entries 126.

As illustrated in FIG. 1B, each Database Entry 126 will typically alphanumeric information that include a Universal Resource Locator (URL) 128, often referred to as a "link", identifying the location or address on the Web of a corresponding HTML document, a Title 130 containing text of any arbitrary length and usually comprising a name of the HTML document, a Text 132 of any arbitrary length and usually comprising a brief description of the HTML document or its contents. Each Database Entry 126 may also include a Date 134 containing the date and time the "link" was last updated, and may include Keywords 136, which may contain one or more keywords characterizing the HTML document and used to search for and locate the corresponding Database Entry 126. In other implementations, such as electronic mail systems, for example, the role of URLs in the following discussions may be fulfilled by electronic mail addresses of various forms, in a manner that will be well and easily understood by those of ordinary skill in the relevant arts.

As is well known and understood in the relevant arts, a user of Local System 112 may use a web program executing on Local System 112, such as Netscape Navigator, to access the Web and, with particular regard to the present invention, to access Server System 114 to search for Web Servers 118 having information sought by the user. Server 114 will then access and search Indexed Database 124 to locate Database Entries 126 relevant to the user's request, and will return at least portions of the Database Entries 126 to Local System 112, such as the URL 128, Title 130 and Text 132. The user of Local System 112 may then use the returned URL's 128 to access and retrieve the corresponding HTML documents from Web Servers 118 and may store a URL 128 returned from Server System 114 for subsequent use, together with its associated information. The user of Local System 112 may also, as is common practice, capture and store URLs 128 of documents and sites and their associated information, such as Title 130, and perhaps Text 132, from a document or site accessed on a Web Server 118. Again, in other implementations, such as electronic mail systems, for example, the role of a web server and index may be fulfilled by electronic mail servers of various forms and electronic mail indexes residing on electronic mail servers, in a manner that will be well and easily understood by those of ordinary skill in the relevant arts.

According to the present invention, Server System 114 further includes a Visual Links Automatic Capture Engine 138A which, as described in further detail in the following, accesses HTML pages located in Web Servers 118 by Network Data Collector and Indexing Server 122 and constructs a Visual Links Database 140 which contains Visual Links 142 corresponding to the HTML documents indexed in Database Entries 126. As shown in FIG. 1B, and as will be discussed in further detail in a subsequent description, a Visual Link 142 will include alphanumeric information including a Universal Resource Locator (URL) 128 and may include a Title 130, a Text 132, and a Date 134, and may include Keywords 136.

In addition, however, a Visual Link 142 includes a Graphic Icon 144 which is generated or extracted from the graphics and text information present in the corresponding HTML document, or other type of file, by Visual Links

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Automatic Capture Engine 138A and which, as described in further detail in the following, serves as a visual representation to the user of the associated document or file. Yet again, in other implementations, such as electronic mail systems, for example, the role of Graphic Icons 144 in the following discussions may be fulfilled by graphic representations of various forms of files, locations or recipients on a network, such as photographs of electronic mail recipients, in a manner that will be well and easily understood by those of ordinary skill in the relevant arts.

In alternate embodiments of Server System 114, for example, one which operates entirely with Visual Links 142, Visual Links Database 140 may entirely replace Indexed Database 124. In more typical embodiments, for example, until or unless Visual Links 142 are universally adopted, Server System 116 will operate with a mixture of text only links and Visual Links 142. Such systems may be implemented as described above, with matching, linked entries in Indexed Database 124 and Visual Links Database 140, or with text only links stored in Indexed Database 124 and Visual Links 142 stored in Visual Links Database 142. In yet other embodiments, Server System 114 may be implemented with the text portions of all links in Indexed Database 124 and any corresponding Graphic Icon 144 stored in Visual Links 142 with the text and graphics portions linked to one another, or Server System 114 may be implemented with only a Visual Links Database 140, as described above, but with the Graphic Icon 144 component of all text only links left empty.

Finally in this regard, it has been described that in certain implementations of Server System 114, Graphic Icons 144 may be generated by a Visual Links Automatic Capture Engine 138A residing in a Server System 114 from the text and graphics information contained in each HTML document, or other type of file that has been accessed by Server System 114. Graphic Icons 144 may also be generated in a like manner by a user of a Local System 112, using an implementation of Visual Links Automatic Capture Engine 138A residing in the Local System 112, or by the operators of a Web Server 118, again using a Visual Links Automatic Capture Engine 138A. It will also be noted that Graphic Icons 144 need not be generated from an HTML document by a Visual Links Automatic Capture Engine 138A, but may be generated independently by a user of a Local System 112 or the operators of a Server System 114 or a Web Server 118, or even by an independent supplier of pre-made Graphic Icons 144 using, for example, virtually any of a wide range of well known and readily available graphics creation programs, and may be used subsequently in the construction of Visual Links 142 or, for example, to replace an already existing Graphic Icon 144 associated with a Visual Link 142.

In a like manner, Visual Links 142 may also be generated or otherwise created by the operators of Web Servers 118, by the operators of Server System 114, or by the users of Local Systems 112, or otherwise provided. The Visual Links 142 so created may be embedded in the HTML documents residing in Web Servers 118 or in a Server System 114 or Local System 112, or may be stored in indexes or databases residing in a Web Server 118, a Server System 114 or a Local System 112. For example, a Visual Links 142 may be read directly from an HTML document or other file by Network Data Collector and Indexing Server 122, stored in Indexed Database 124 or Visual Links Database 140, as described above, and provided to and stored in a Local Server 112 from Server System 114. In further example, a Visual Link 142 may also be read directly by Local Server 112 when the

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document or other file is accessed by Local Server 112, typically by the user "clicking" on a representation of the Visual Link 142 embedded and displayed in the HTML page or file, as described below, in the manner usual for HTML links.

Considering Visual Links 142 further, and assuming the use of HTML documents other forms of files supporting linking, such as files generated or operated upon application programs supporting Microsoft Windows Object Linking and Embedding (OLE), a Visual Link 142 can be inserted into an HTML document by means of an OBJECT Tag or an EMBED Tag 146, depending upon whether Netscape of ActiveX standards are followed. As illustrated in FIG. 1C, the OBJECT or EMBED Tag 146 follows an IMG Tag 148 displaying a Visual Links Symbol 150 and is hyperlinked 152 to the URL 154, and associated link related information, so that a user "clicking" on Visual Links Symbol 150 will access the URL 154 and associated information. In an alternate implementation, alternate hyperlinked text or graphics, such as a Visual Link 142 may be included with the OBJECT or EMBED tag.

In this regard, it will be appreciated by those of ordinary skill in the relevant arts that there are a number of ways for a user to interact with a Visual Links Symbol 150. For example, when a user passes a mouse cursor over a Visual Links Symbol 150 or icon, the symbol or icon may be replaced by the URL or by key words or by a descriptive text so long as the cursor is collocated with the symbol or icon, or this information may be displayed in a separate window, such as a "pop-up" window.

Referring now to Local System 112, as shown in FIG. 1A, Local System 112 is, for example, a personal computer executing the Microsoft Windows operating environment and including typical components, such as a Disk Drive 156A and a Memory 156B for storing programs and data, a Processor 158 for operating on the data under control of the programs, and a Display 160 for providing a visual display of the operations of the system. Although not shown explicitly in FIG. 1A, it will be understood by those of ordinary skill in the relevant arts that Server System 114 and Service System 116 will likewise include a Disk Drive 156A and a Memory 156B for storing programs and data and a Processor 158 for operating on the data under control of the programs and will generally include a Display 160 for providing a visual display of the operations of the systems.

As also shown in FIG. 1A, Local System 112 further includes a Web Access Program 162, such as Netscape Navigator, as will Server System 114, although in a different form and implementation and capabilities from that in Local System 112, and, according to the present invention, a Visual Links Control 164 and a Visual Links Organizer 166, both of which are associated with and operate in association with Web Access Program 162. Associated with Visual Links Control 164 and Visual Links Organizer 166 is a Visual Links Library 168 for storing Visual Links 142. Local System 112 may also include a Visual Links Automatic Capture Engine 138A or 138B, perhaps in more limited form than that implemented in Server System 114, thereby allowing a user of Local System 112 to create Visual Links 142 locally, rather than only downloading Visual Links 142 from Server System 114 or Web Servers 118.

Visual Links Control 164 operates to interface and integrate Visual Links 142, Visual Links Organizer 166 and Visual Links Automatic Capture Engine 138A or 138B, if present, into Web Access Program 162, and allows a user to access the target of a Visual Link 142 and to save a Visual

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Link 142 in Visual Links Library 168 or a file. Visual Links Organizer 166, in turn, allows a user to create and edit Visual Links 142, to store Visual Links 142 in Visual Links Library 168, and to otherwise manage Visual Links 142 and Visual Links Libraries 168. Visual Links Organizer, which will be described in detail further below, also allows a user to organize the display of Visual Links 142 in a Visual Links Library 168.

As shown in FIG. 1A, a Local System 112 may also include a Visual Links Screen Saver 170 which is connected from Visual Links Library 168 and which is responsive to the operations of Local System 112 in the usual manner of screen savers to generate a screen saver display on Display 160. The design and operation of screen savers is well known and understood by those of ordinary skill in the relevant arts and, as such, will not be discussed further herein. It must be noted, however, that in accordance with the present invention the visual elements of the screen saver display are comprised of Graphic Icons 144 from Visual Links Library 168, and may be selected by Visual Links Screen Saver 170 at random or by user control and may, for example, include the most frequently used Graphic Icons 144 or selected layouts of Graphics Icons 144, as will be described in a following discussion. In addition, the usual operation of a screen saver utility in disabling the screen saver and returning the display presented on Display 160 to the executing operations of the system upon, for example, any mouse input by a user, may be selectively disabled, thereby allowing the mouse to be used in conjunction with the display of Graphic Icons 144 by Visual Links Screen Saver. This operation, in turn, allows the user to select, or "click", a Graphic Icon 144 being displayed by Visual Link Screen Saver 170, in the same manner as Web Access 162 and Visual Link Organizer 166, to invoke Web Access 162 and to access the site, document or file associated with the selected Graphic Icon 144.

Lastly, it will be noted that FIG. 1A illustrates additional elements of the present invention, specifically a Layout Table 412 and a Display Generator 414 in Visual Links Organizer 166, which will be discussed in a later description of the generation and use of display layouts of Graphic Icons 144 and other displayable visual objects.

Finally, it must be noted that the functions and operations of Visual Links Control 164 and Visual Links Organizer 166 are implemented through the standard functions and utilities of Microsoft Windows in the presently preferred embodiment. The functionality and capabilities of Microsoft Windows are well known to those in the relevant arts and are well described in readily available publications, such as "Windows 3.1 Programmer's Reference" by James W. McCord and published by Que Corporation and "Inside OLE 2" by Kraig Brockschmidt and published by Microsoft Press, which are incorporated herein by reference as necessary. As such, the following will describe Visual Links Control 164 and Visual Links Organizer 166 only as necessary to describe and understand, for example, the operation of Visual Links Automatic Capture Engine 138A and of Visual Links Organizer 166 in organizing the display of Visual Links 142, which will be described in detail.

2. General Description of Visual Links Automatic Capture Engine 138 and Visual Links Organizer 166 (FIGS. 1A-1D, 2A and 2B)

As described above, a primary function of Visual Links Automatic Capture Engine 138, hereafter referred to generally as a Visual Links Automatic Capture Engine 138 and

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representing both Visual Links Automatic Capture Engine 138A and at least certain aspects of the embodiments of a Visual Link Manual Capture Engine 138M, is to extract graphics information from the text and graphics presented on a page of an HTML document, or other file containing graphic information, to be incorporated into a Visual Link 142 as a Graphic Icon 144. As will be seen in the following description, and because the icons generated by Visual Link Capture Engine 138 are formed of graphics information extracted from the HTML page or document referred to by the Visual Link 142 containing the Graphic Icon 144, the icons of the present invention provide visually strong, distinctive images to be used in visually identifying the corresponding HTML page or document to a user. In addition, and as will also be seen from the following, while not in itself a compressed image, a Graphic Icon 144 may require significantly less space to store and display than do the typical compressed "thumbnail" images of the prior art, and less network time to communicate from one system to another. Further, the Graphic Icons 144 of the present image, being generated from the rich variety of images available on HTML documents or pages, or in other graphics files, provide a range and variety of images not generally available in the standard types of "icons" used, for example, in Microsoft Windows applications, in part because of the slightly larger size of Graphic Icons 144 and in part because of the relative ease with which visually distinct Graphic Icons 144 are generated.

An essential function of Visual Link Capture Engine 138 is the extraction of graphics information from the graphically represented text and images present in an HTML document or page, or other form of image file, and the forming of that graphics information into a Graphic Icon 144.

Visual Link Capture Engine 138 may perform this operation in a number of ways, for example, providing a user with a mechanism to manually delineate and copy an area of an image, such as an area of an HTML page or document or other form of graphic image, to comprise the graphic information that is used to create a Graphic Icon 144. Such mechanisms are commonly known and implemented using, for example, the functions and operations available in the Microsoft Windows operating environment and used, for example, in Microsoft Paint and similar drawing programs. This approach may be used, for example, in an implementation of Visual Link Capture Engine 138 used in Local System 112, and designated in FIG. 1A as Visual Links Manual Capture Engine 138M, where a user is creating Visual Links 142 for a relatively small number of HTML documents or pages or a relatively small number of other image files.

A user may also use the facilities of a graphic paint or annotation system to add, replace, or delete, in any combination, or otherwise modify, selected parts of a selected area. A user may also, as an alternative or in combination with such operations, create a part of or the entirety of the visual image by the graphics operations of such a graphics application program or utility, or by selection of a part of or the entirety of the visual image from an independent library of images, and may modify an image or a part of an image selected from a library of images for such purposes. In such cases, the image part of a Visual Link 142 is thereby not derived, at least not totally, from the imagery of an HTML image.

In this regard, it is discussed in the following detailed descriptions of a Visual Links Automatic Capture Engine 138 that it has been found preferable, in the presently

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preferred embodiment, that the dimensions and aspect ratios of the Graphic Icons 144 be selected to allow efficient packing into a given display area. For these reasons, the dimensions and proportions of Graphic Icons 144 are preferably selected from a relatively small set of possible dimensions and aspect ratios to allow the efficient organization, packing and display of Graphic Icons 144 in a directory window. The method for manual selection of an area of an image to be used in generating a Graphic Icon 144 thereby preferably represents to the user not only the original image, or a section of interest thereof, and the area selected by the user for possible use in generating the Graphic Icons 144, but also the possible Graphic Icons 144 that would result from the proposed selection.

For example, the user may be provided with a mouse controlled "stretchy rectangle" to use in selecting a portion of the original image for possible use in generating a Graphic Icon 144, in the manner well known, for example, in Microsoft Windows graphics programs such as the Microsoft Paint program. The Graphic Icons 144 generation program would then display one or more representations of the Graphic Icons 144 that could result from the use of the area delineated by the user, thereby allowing the user to select one of the possible Graphic Icons 144 that would result from that selection. In another embodiment, and as illustrated in FIG. 1D, the user would use, for example, the mouse cursor to designate one corner, such as the upper left corner, of an area of the original image and the Graphic Icon 144 generation program would overlay and display on the original image a set of rectangles representing the set of possible Graphic Icons 144 wherein the set of rectangles conform to the range of dimensions and aspect ratios selected for the Graphic Icons 144, the upper left corner of each of the displayed rectangles being located at the initial point designated by the user. The user could then select one of the displayed rectangles as delineating the area of the original image to be used in generating the Graphic Icon 144, for example, by "clicking" on the lower right corner of the chosen rectangle.

As illustrated in FIG. 1D for an exemplary implementation, the upper left corner of the delineating rectangle, designated in FIG. 1D as corner A, is first positioned so as to identify the upper left of the intended area. Thereupon, in the present example, four candidate aspect ratio rectangles are displayed superimposed on the image, the bottom right corners being designated in FIG. 1D as corners B, C, D and E. The user then selects one of the candidate aspect ratio rectangles by "clicking" on the bottom right corner of the selected candidate aspect ratio rectangle, whereupon the unselected rectangles cease to be displayed. The user may then re-position the entire selected candidate aspect ratio rectangle to select the most appropriate area of the image by "dragging" the upper left corner of the selected rectangle, and may resize the selected rectangle to fit the most appropriate area by dragging the bottom right corner of the selected rectangle, with the system enforcing the aspect ratio constraint for the selected rectangle.

Visual Link Capture Engine 138 as implemented in Server System 114, however, will preferably provide an automatic mechanism, designated in FIG. 1A as Visual Links Visual Link Capture Engine 138, for selecting areas of graphics images and forming them into Graphic Icons 144 because the large number of Visual Links 142 that must be generated. It may also be desirable to provide an implementation of Visual Links Visual Link Capture Engine 138 for use in Local System 112, however, for example, when a user generally lacks the skill, interest or time to create Visual Links 142 manually.

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Such visual links may, for example and in one possible implementation, be held only temporarily, for example, for the duration of a session, thereby providing a visual reference for revisiting a server that was accessed earlier in the session.

In a like manner, it may be preferable to provide an implementation of Visual Links Manual Capture Engine 138M in Server System 114 for use by the operators thereof, for example, when a source image or page has no suitable areas from which Visual Links Visual Link Capture Engine 138 can generate a suitable Graphic Icon 144 or when the results generated by Visual Links Visual Link Capture Engine 138 are ambiguous. Such results may occur, for example, when a page or image is entirely comprised of low contrast visual structures or when all of the visual structures therein are comprised of fine detail text or graphics.

One solution to this problem is, and for example, to use as the "image" a few words or a legible part of the URL 154, such as the string of characters typically following "www".

In addition, and if and when the capture engine operates automatically, it may be advantageous to display the document or web page in a selective way, for example, by omitting parts of the page comprising small text or material otherwise not directly and sufficiently descriptive of the page, such as advertisements. Such parts of a page may be omitted by use of the methods described in the following for selecting areas of an image to be used in creating Graphic Icons 144, for example, and advertisements or similar areas of a page may be omitted based upon their non-image contents, such as links to other sites.

A Visual Links Visual Link Capture Engine 138 for selecting areas of graphics images and forming them into Graphic Icons 144 must meet a number of requirements and must provide a number of functions. For example, the Visual Link Capture Engine 138 must provide an evaluation procedure and mechanism for comparing the worth, that is, the visual strength, of various proposed regions of an image, and at least affirming the validity of a region of an image as a source of image information for a Graphic Icon 144. The evaluation procedure will appropriately weight and balance the image areas, bold text areas and logos, and will be relatively insensitive and unresponsive to areas containing small fonts and fine details.

The Visual Link Capture Engine 138 will also provide an efficient mechanism for searching an image, such as an HTML page or document or other form of image, and identifying possible areas or regions to be evaluated or selected for use in creating the Graphic Icon 144. In this regard, a given image may contain an extremely large number of possible subregions which may serve as source regions for a Graphic Icon 144; for example, a 640 pixel by 1480 pixel bitmap image may contain more than 10 billion possible regions that might be used to generate a Graphic Icon 144.

In addition, the original image may appear as or be comprised of a set of definitions of graphic objects, as may be defined, for example, by hypertext markup language (HTML). In these instances, it may be desirable to cull the graphics objects for the purpose of omitting from the "original" image, and thus from consideration for use in a Graphic Icon 144, such parts of the "original" image as are commonly not suitable for use in creating a Graphic Icon 144. Examples of such may include fine text, a wallpaper background, or bitmap parts that may with high probability be automatically classified as advertisements or other pictorial subparts irrelevant to the purpose of visually depicting

the essential visual appearance of the original image. Again, such parts or components of an original image may be culled based upon the methods described herein, or upon their contents.

Finally, the image information extracted from a graphics image, which may be of various dimensions and proportions, must be shaped into a Graphic Icon 144. In this regard, however, a single fixed aspect ratio, for example, of 3:4, for either the extracted graphics information or the Graphic Icon 144 is too constraining considering the possible areas or regions that may be selected from a given graphics image as most distinctive and most unique to that graphics image, both in itself and relative to other graphics images. It is preferable, however, to efficiently organize and display the maximum number of Graphic Icons 144 in, for example, a directory window, and, for this reason, the dimensions and aspect ratios of the Graphic Icons 144 will preferably be selected to allow efficient packing of any arbitrary set of icons into a given display area. For these reasons, the dimensions and proportions of Graphic Icons 144 are preferably selected from a relatively small set of possible dimensions and aspect ratios to allow the efficient organization, packing and display of Graphic Icons 144 in a directory window.

Visual Link Capture Engine 138 will therefore provide an Visual Link Capture Engine 138 that automatically shapes the extracted image information into a Graphic Icon 144 selected from a relatively small set of possible dimensions and aspect ratios that are selected for efficient packing into a display area

In a related problem, Visual Links Organizer 166 will provide a mechanism for efficient packing any arbitrary collection of Graphic Icons 144 having various dimensions and aspect ratios from that set of dimensions and aspect ratios into a display area

First considering the evaluation procedure and mechanism for comparing the worth, that is, the visual distinctiveness, of various proposed regions of an image, and affirming the validity of a region of an image as a source of image information for a Graphic Icon 144, it is apparent that bold text and pictorial material, that is, large or highly contrasting features or areas of text or image, are significantly more visible and distinctive than are areas of, for example, fine text or low contrast pictorial material.

According to the present invention, as and described in further detail below, the most visually significant features of an image, that is, the largest and highest contrast or highest visibility features, are emphasized, and the less significant features suppressed, by coarsening and blurring the overall image, which is usually in the form of a bitmap image. Also according to the present invention, the features or regions of most significance in an image will generally be as evident in a gray-scale version of a bitmap as in a color version, so that a gray-scale version of the image may be used rather than the color version to simplify and speed the task of identifying the regions or features of most significance.

Pursuant to evaluation, therefore, a coarse grayscale version of the original image, for example, $\frac{1}{4}$ the linear size in pixels of the original image, is low-pass filtered, and an "edge" image is made from the coarse grayscale version of the original image, wherein the edge image is regions having high numerical values in the regions of high non-uniformity of the filtered image. The amount of blurry "edge" in any subrectangle, relative to its size, is taken as an approximation of the degree to which this rectangular area contains visually bold or significant information.

It is anticipated that some very small regions of the coarse grayscale version of the original image may contain high evaluations of edge-per-area, yet not be suitable for use as Graphic Icons 144. Therefore, and according to a presently preferred embodiment of the invention, candidate areas are required to be of predetermined minimum size and the criteria by which regions are rejected for consideration includes size. As such, and in the present implementation, if two areas exhibit the same average amount of edge-per-pixel, then the larger of the two is deemed to be the better region to be used in creating the Graphic Icon 144.

Because the Visual Link Capture Engine 138 searches for bold and coarse features, and because, for reasons discussed in the following, it is not necessary to locate the boundaries of the Graphic Icon 144's source area in the original image or in the coarse grayscale version of the original image with pixel accuracy, the Visual Link Capture Engine 138 performs a first search with a second, very low-resolution image. The very low resolution image is constructed, for example, made from the $\frac{1}{4}$ size edge image and is, for example, $\frac{1}{16}$ the linear size of the original image, or $\frac{1}{4}$ the size of the $\frac{1}{4}$ scale edge image. The use of such a low resolution image, have a proportionally smaller number of total pixels and a correspondingly smaller number of pixels in each sub-region thereof, the Visual Link Capture Engine 138 can perform a relatively thorough search, involving crude test-for-appropriateness of a very wide range of sizes, locations and aspect ratios of initially selected regions of the original image. Subsequent refinement of the area or areas thus found is then based on the more accurate $\frac{1}{4}$ size edge image.

Once a suitable area of the $\frac{1}{4}$ size edge image is found, the candidate area, which in the present embodiment of the invention is a rectangle, is refined by the process of iteratively pushing one or another side of the rectangle outward by one row of pixels so long as this increases the rectangle's worthiness for use in creating the Graphic Icon 144, and finally adjusting each side of the rectangle inward or outward accordingly as the rows of pixels just inside or just outside of the rectangle have or do not have significant edge indications. That is, a side of the rectangle is retracted the if the strip of pixels inside that side contains little or no edge feature and the side of the rectangle is extended if the edge indications in the strip of pixels outside that side indicate the continuation of features already partly contained in the rectangle.

Finally, it has been described above that the rectangle of image information extracted from a graphics image as representing the visually most distinctive and unique area of the original image may be of various dimensions and proportions. It has also been described that the selected rectangle of graphic information is then preferably shaped into a Graphic Icon 144 having a size and aspect ratio selected from a relatively small set of possible dimensions and aspect ratios to allow the efficient organization, packing and display of Graphic Icons 144 in a directory window.

In a presently preferred embodiment of the invention, the set of possible aspect ratios for the final Graphic Icons 144 have been chosen to include aspect ratios of 6x2 (units of height to width), 4x3, 3x4 and 2x6 as these aspect ratios result in Graphic Icons 144 having the same total area and because an arbitrary group of Graphic Icons 144 having these aspect ratios will pack efficiently into a given display area. The ultimate icons will therefore be resized, according to one exemplary set of sizes, to be 120 pixels high by 40 pixels wide, or 80 pixels high by 60 pixels wide, or 60 pixels high by 80 pixels wide, or 40 pixels high by 120 pixels wide,

or they may be slightly less in one or both dimensions but will be deemed nominally to "occupy" these screen display areas. Accordingly, and because the region of the original image that has been selected as visually most distinctive and unique will rarely have one of these predetermined aspect ratios, a final adjustment of the area or region of graphic information that has been selected and extracted from the original image is necessary to conform the selected area or region to one of these predetermined aspect ratios.

A number of such adjustment processes are possible, and the presently preferred embodiment of the Visual Link Capture Engine 138 may or does use any or any combination of these adjustment processes. For example, in a first process, the icon may be left in the shape as extracted from the original image and placed in a final display into the best-fitting shape of area, leaving blank unused area on left and right, or on top and bottom. In a second process, the icon can be distorted by a vertical or horizontal stretch so that it fits such an area and, in a third process, the area from which the icon is cut may be extended either vertically or horizontally to match an acceptable shape while, in a fourth process, a combination of stretching, of up to, perhaps, 10%, may be combined with an extension of the source area. Finally, in yet another method, and if and where a background color can automatically be discerned, that color may be used to fill the extra area so that the icon's sides do not make a disconcerting cut through other visual objects in the vicinity.

In all cases, therefore, the Graphic Icons 144 are produced by appropriate scaling, so that they each occupy the same amount of screen area and pack efficiently into the display screen area, such as directory window. In addition, and as discussed in the following, the Graphic Icons 144 may be but are not necessarily all created to the same color scheme, such as the 256 color standard used in Microsoft Windows, so that they can be displayed simultaneously, and in certain implementations the final color compatibility may be achieved by a color conversion just preceding the display of the icons to a user. Finally, and in addition to the above described advantages, each display of Graphic Icons 144, such as a directory or folder in the directory, will, as a whole, present a certain distinctiveness because of its near-unique combination and placement pattern of Graphic Icons 144, thereby providing the user with a further visual aid for looking for, remembering and recognizing individual Graphic Icons 144.

Finally, the various images and versions of images used by the Visual Link Capture Engine 138 of the present invention and described above are illustrated in FIG. 2A wherein Image 210 represents the original image of an HTML page or document, or other graphics image, and Grayscale Image 212 represents the $\frac{1}{4}$ size grayscale image generated from Original Image 210 and Filtered Grayscale Image 214 represents low pass filtered, that is, coarsened and blurred image generated from Grayscale Image 212 and Edge Image 216, in turn, represents the edge image generated from Filtered Grayscale Image 214. Coarse Edge Image 218 then represents the $\frac{1}{16}$ scaled image generated from Edge Image 216 for purposes of identifying candidate regions from which to construct the Graphic Icon 144, while Graphic 44 Image 220 represents the region of Original Image 210 that has been selected, as described above, for construction of the Graphic Icon 144, and Graphic 44 represents Graphic 44 Image 220 after adjustment to one of the predetermined sizes and aspect ratios chosen for Graphic Icons 144, that is, Graphic 44 is the final Graphic Icon 144.

It will be noted that the presently preferred embodiment of Visual Link Capture Engine 138 operates with grayscale

images, that is, the relative "brightness" of image components, in identifying those areas of an original image most suitable for incorporation into a Graphic Icon 144. As such, the following descriptions of Visual Link Capture Engine 138 will primarily focus on the grayscale implementation of the processes for generating Graphic Icons 144.

Alternate implementations of the Visual Link Capture Engine 138, however, may utilize the color information, that is, such as the red, green and blue components, of Original Image 210 in identifying the visually most significant and unique region of the image. The methods, processes and mechanisms of the capture engine of the present invention as implemented for the use of color information are very similar to those for the use of grayscale images, however. As such, the use of color image information will be discussed briefly in the following, using FIG. 2A for purposes of illustration, before continuing with a detailed discussion of the mechanisms using grayscale information and those of ordinary skill in the relevant arts will understand the adaptation of the grayscale mechanisms to the use of color information.

In a presently preferred embodiment of a Visual Link Capture Engine 138 using color information, the colors are not treated separately through the entire process. Instead the color information is included or combined into a single edge image corresponding to and equivalent to $\frac{1}{4}$ scale Filtered Grayscale Image 214 and this color Filtered Grayscale Image 214 is then used in the processes and mechanisms described in the following in the same manner as a grayscale Filtered Grayscale Image 214.

As will be described in the following with regard to the grayscale implementation of Visual Link Capture Engine 138, the amount of "edge" at a given pixel of an image is an indication of how much the "brightness" of the image is changing at that pixel and is thereby an indication of the distinctiveness of that region of the image relative to other regions of the image. In the implementation of Visual Link Capture Engine 138 using color information, however, the amount of "edge" at a pixel of the image is an indication of how much the red or green or blue components of the image, or any combination of the red, green or blue components of the image, are changing in that region, as well as an indication of how much the "brightness" of the image is changing at that region. The amount of "edge" therefore reflects the amount of "color-and-brightness" change, which is generally referred to in brief as the "color" change.

This embodiment of Visual Link Capture Engine 138 thereby determines a "color change" at each pixel of the blurred image wherein the color change may be usefully defined and used as any of a number of measures. For example, the color change may be defined and determined as the red component change plus the green component change plus the blue component change plus the brightness component change at a pixel, wherein the brightness component change is the only component considered in the presently preferred grayscale implementation of the capture engine described below. In one implementation, the red component change at a pixel may, for example, be determined as the red component left-right change across the pixel plus the red component above-below change across the pixel, and likewise for the green, blue and brightness components. The left-right and above-below changes at a given pixel and for a given component may, in turn and for example, be defined as the absolute values of the differences between that component at the pixels to, respectively, the left and right and above and below that pixel. In yet other implementations, the change in a component may be defined as either the

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larger of the absolute value of the difference in the component between the top and bottom neighbors of each pixel or the absolute value of the difference in the component between the right and left neighbors of each pixel, thus separately considering changes occurring in the horizontal and vertical directions.

The "amount of edge" at given pixel, in turn, may be determined as the average, for that pixel, of each of the component changes and, in another implementation, as the maximum of the component changes, rather than the average.

Whichever method is used, this process thereby determines for, each pixel, a value depending upon both how much the brightness component is changing in a given direction at each pixel and how much the red, green and blue components are changing in that direction at each pixel. For example, given a "pie chart" wherein the different sections of the chart have approximately the same brightness but are drawn in different colors, this process will determine significant "edge" along the radial division lines between the sections of the chart.

It will be noted that in yet another alternate implementation of the capture engine using color information, Visual Link Capture Engine 138 may generate three Grayscale Images 212 wherein each Grayscale Image 212, respectively designated in FIG. 2A as Red Color Image 212R, Green Color Image 212G, and Blue Color Image 212B, contains the grayscale equivalent values of, respectively, the red, green and blue components of Original Image 210. The Visual Link Capture Engine 138 will then execute the same operations as described above, but for each of the three Color Images 212R, 212G and 212B separately, and will generate three corresponding Coarse Edge Images 218, one corresponding to each of Red Color Image 212R, Green Color Image 212G, and Blue Color Image 212B. In one implementation, the three Coarse Edge Images 218, which could possibly correspond to three different candidate regions of Original Image 210, are then evaluated as described above to select the visually most significant and unique region of the original image to use in constructing the Graphic Icon 144 as described above.

In one alternate implementation of the three color image process, the Visual Link Capture Engine 138 uses the three original Coarse Edge Images 218 corresponding to Red Color Image 212R, Green Color Image 212G, and Blue Color Image 212B to select the region or regions of the original image providing the visually most significant and unique region or regions of the original image, each being selected on the basis of a single color component, that is, red, green or blue. The result may again be one, two or three different candidate regions of the original image, depending, for example, on whether any of the single color component Coarse Edge Images 218 overlap. The Visual Link Capture Engine 138 then generates a Red Color Image 212R, Green Color Image 212G, and Blue Color Image 212B for each candidate region selected on the basis of the individual color components. In most instances, however, the automatic color mechanism need only generate two new grayscale images for each region as each region will already be represented by one grayscale image. For example, if a given region has been selected of containing the visually most significant area of Original Image 210 based upon the red color component, a Red Color Image 212R and the corresponding Filtered Grayscale Image 214, Edge Image 216 and Coarse Edge Image 218 will already exist, so that the Visual Link Capture Engine 138 need generate this images only for the blue and green components.

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The capture mechanism would then perform the above analysis of each candidate region, but three times, once for each color component of each candidate region, and combines the three evaluations for each candidate region to generate a value representing the visual merits of each candidate region. The Visual Link Capture Engine 138 then selects the visually most significant of the candidate regions to use in constructing the Graphic Icon 144 as described above.

Returning to consideration of the operation of Visual Link Capture Engine 138 using only brightness information, the above described capture of image information and creation of a Graphic Icon 144 can be illustrated by way of an example. In this instance, it is assumed that the Original Image 210 exists in one of the more complex image formats, such as the 256-color bitmap image format wherein each byte value 0-255 corresponds to a color whose red, green and blue components are defined in an auxiliary color lookup table (LUT).

The Visual Link Capture Engine 138 first reads the color LUT and composes a gray-scale LUT whereby the brightness of each of the 256 colors is taken to be the average of that color's red, green, and blue component values. It will be noted in this regard that alternative and more refined measures of brightness are known to those of skill in the relevant arts, but this method is sufficient for the present embodiment of the Visual Link Capture Engine 138. Then, and assuming for purposes of the present example that the bitmap comprising Original Image 210 is free of border, marginalia or other extraneous accouterments, the Original Image 210 bitmap is read and processed into a ¼ size grayscale image comprising Grayscale Image 212. As such, 116 source pixels of Original Image 210 contribute to each destination pixel of Grayscale Image 212 and this conversion is accomplished by adding and averaging the brightness of the 116 source pixels corresponding to each Grayscale Image 212 pixel, as taken from the gray-scale LUT.

The low-pass filtered image comprising Filtered Grayscale Image 214 is then created from Grayscale Image 212 by use of a kernel array of coefficients, that is, by multiplying neighboring pixels of Grayscale Image 212 by the numbers of the kernel array and dividing by 18, wherein an exemplary kernel array may be represented by

0	0	1	0	0
0	1	2	1	0
1	2	2	2	1
0	1	2	1	0
0	0	1	0	0

and wherein the value 18 is the sum of the multipliers in the kernel.

In then creating Edge Image 216, it must be noted that the value of each pixel of Edge Image 216 depends on the values of the left, right, top and bottom neighbors of the corresponding source pixel in Filtered Grayscale Image 214. The value of each pixel of Edge Image 216 may therefore be found by finding the brightness difference between left and right neighbors and the brightness difference between top and bottom neighbors, and then adding the absolute values of these values, multiplying each result by a first constant, subtracting a second constant, and clipping the result for each pixel of Edge Image 216 to a minimum value of 0 and maximum value of 255. Alternatively, the value of each pixel of Edge Image 216 may be determined as the absolute difference between the corresponding left and right vs. top

and bottom pixels of Filtered Grayscale Image 214, which tends to emphasize horizontal and vertical edges in the images. In yet another alternate implementation, the same method may be executed, but using the red, green and blue color components, as described above, thereby causing the Visual Link Capture Engine 138 to evaluate the candidate regions of the original image on the basis of image structures exhibited by differences in color as well as brightness.

The value assigned to each block, or coarse pixel, of the resulting extremely coarse $\frac{1}{16}$ size edge image, that is, Coarse Edge Image 218, is then the sum of a corresponding 4x4 pixel block of Edge Image 216 pixels, these values being stored as word-size values rather than byte-size values.

The Visual Link Capture Engine 138 then determines the rectangular region to be used as source for the Graphic Icon 144 by executing four distinct steps, or operations:

- (1) an initial rectangular region is found by exhaustive search in the very coarse image, Coarse Edge Image 218;
- (2) by reference to the $\frac{1}{4}$ size image, Edge Image 216, this area is extended on any or all sides so long as its figure of merit increases;
- (3) by iterative successive treatment, each side of the grown rectangle is adjusted either in or out as best fits the edge structure found in the local area (cutting back if the rectangle has extended into empty space and pushing out if structure seems to have been truncated); and,
- (4) the otherwise "final" area is adjusted to conform to one of the selected aspect ratios to form the Graphic Icon 144.

Considering each of these operations further, the mechanism for examining candidate rectangles will be discussed in a following detailed description and it will be shown therein that the mechanism used in the presently preferred embodiment of Visual Link Capture Engine 138 permits fast summing values in candidate rectangles, thereby allowing Visual Link Capture Engine 138 to test a large number of candidate rectangles quickly and efficiently. As such, the initial candidate rectangle is found by exhaustive examination of all candidate rectangles in a Coarse Edge Image 218 having widths in the range of 6 through 10 pixels less-than-full-width pixels and heights in the range of 6 through 10 less-than-full-height pixels. That is, the starting rectangle must be at least 6 pixels of the $\frac{1}{16}$ size image and at most ten less than the full size rectangle in both the horizontal and vertical directions so that the search in the coarse space is exhaustive except for very thin and very tall or very wide rectangles. The evaluation of these candidate rectangles on the same basis that is subsequently used to evaluate growth of the selected rectangle, which will thereby be equally exhaustive and with the same possible exceptions. It will also be noted that 6-through-10 pixel high by 6-through-10 pixel wide rectangles of Coarse Edge Image 218 were selected as providing areas having an acceptable probability of containing at least parts of visually significant image structures while being sufficiently small as to reduce the processing burden.

As described above, the search for and subsequent modification of suitable candidate rectangles for the generation of Graphic Icons 144 requires a method for the evaluation of each rectangle or modification thereof, that is, the determination of a "figure of merit" or "figure of assurance" for each candidate rectangle. The search for a suitable area of an image to comprise of Graphic Icon 144, or a proposed modification of a candidate rectangle to determine whether

the candidate rectangle is improved by moving the sides of the rectangle inwards or outwards, results in each case in a local maximum in the total search space wherein the local maximum has a "value" and a "sharpness" which together can be used to express a figure or merit or assurance that the rectangle is the or a proper area to be used in generating a Graphic Icon 144. In addition to being used by Visual Link Capture Engine 138 to evaluate a candidate rectangle or a modification to a candidate rectangle, the figure of merit or assurance can then be used to flag or otherwise indicate results having a low figure of assurance for subsequent human approval or correction, for example, by use of a Visual Links Manual Capture Engine 138M.

It will be appreciated by those of ordinary skill in the arts that the value component of the figure of merit or assurance of a candidate rectangle is a function of the location of the candidate rectangle in the image and the size of the candidate rectangle. That is, the location of a candidate rectangle determines which area of the image is included in the rectangle and, in turn, is a function of the average amount of image "edge" in the candidate rectangle, wherein "edge" may be defined as the local degree of visual coarse structure non-uniformity of image in the selected area of the image. The degree of local visual coarse structure non-uniformity, in turn, may be generally defined as the amount of contrast, or difference, in brightness or color between adjacent areas in the rectangle and the "sharpness", or abruptness, of the boundary between adjacent areas of different brightness or color in the rectangle, that is, how fast does the change in brightness or color occur when moving from one area to another.

The criteria of "sharpness" also applies in the steps wherein the sides of a candidate are adjusted inwards or outwards to incorporate the entirety of a visually strong local structure already at least partially included in the candidate rectangle into the final candidate rectangle. In this sense, "sharpness" is a measure of how fast and in what direction the figure of merit or assurance value of the candidate rectangle changes per unit distance as a side of the rectangle is moved inwards or outwards.

In this regard, it will be appreciated by those of ordinary skill in the arts with respect to the determination of a figure of merit or assurance of a candidate rectangle that the step of generating Filtered Grayscale Image 214 is essentially a pre-processing step with respect to the search for and evaluation of candidate rectangle wherein small text and low resolution or low contrast areas of the original image are discarded as being of little value in generating a Graphic Icon 144 presenting strong visual components to a viewer.

Finally, the size of the rectangle determines the amount of original image incorporated into the candidate rectangle and in the presently preferred embodiment of Visual Link Capture Engine 138 is selected on the general principle that a larger candidate rectangle is preferable over a smaller candidate rectangle.

In the presently preferred embodiment of Visual Link Capture Engine 138, therefore, the figure of merit or assurance is determined as a function of the average amount of "edge" per pixel in the rectangle and adding a contribution value that increases, up to a limit, with increasing size of the rectangle. In the presently preferred embodiment, the actual size contribution has two breakpoints with increasing value of the perimeter of the rectangle, such that for rectangles beyond a certain size there is no further value added for a further increase in size of the rectangle. This reduces, but does not eliminate, the possibility of very small disproportionately structured areas from becoming Graphic Icons 144,

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and prevents a potential "run-away" condition whereby the "figure of merit" increases with the size of the rectangle regardless of content.

The near-final operation of pushing a side of a rectangle in or out is performed by computing the amount of edge in the strip of pixels just inside the rectangle and, if significantly lower than average, excluding the strip from the rectangle, that is, pulling the side of the rectangle back, or, if the strip just outside the side of the rectangle contains a significant amount of edge structure, indicating that image structure has been truncated that probably should be included in the region, including the strip in the rectangle, that is, pushing out that side of the rectangle.

Finally, the final sizing and shaping of the Graphic Icon 144 area has been discussed above. However, for the case in which no "filling" or "stretching" is to be done, but the source area is made to conform to an acceptable ratio of, say 6:2 or 4:3 or 3:4 or 2:6, the following are the steps for deciding which sides are to be pushed out, relative to the existing rectangle.

These "rules" for the steps for final sizing and shaping may be represented schematically, including the additional in-between ratios of 5:9 and 1:1 and 9:5 as division points, by:

→6:2←9:5→4:3←1:1→3:4←5:9→2:6←

The meaning of the schematic is:

if the height:width ratio is greater than 6:2, widen the area to 6:2

else if the ratio is greater than 9:5, stretch its height to 6:2;

else if it is greater than 4:3, widen it to make it 4:3;

else if it is greater than 1:1, make it taller so as to make it 4:3;

else if it is greater than 3:4, widen it to make it 3:4;

else if it is greater than 5:9, make it taller to make it 3:4;

else if it is greater than 2:6, widen it to 2:6;

else make it taller to make it 2:6

It should be noted that in the example described above, the final adjustment for a selected aspect ratio has, for the sake of illustration, been slightly simplified. For example, in the most common implementation the final Graphic Icon 144 will have a thin border area on all sides for the purpose of delineating it from neighboring icons in screen layouts containing many icons, as illustrated in FIG. 2B. The candidate areas are therefore slightly smaller, and ratios slightly different, if no distortion whatever is to be allowed in re-sizing from the source image to the icon, although a slight re-sizing may not only be acceptable but even desirable in order to use a more desirably shaped or sized region from the source image.

It must also be noted that the "tiling" of many icons of the various acceptable sizes and shapes, as illustrated in FIG. 2B, is a "bin-packing" problem of tiling geometry and, in certain implementation, such as with a relatively small number of icons per display, for example, 10 to 20, Visual Links Organizer 166, which will be discussed further in the following descriptions, may be implemented by computing and tabulating one arrangement for each maximally achievable icon population distribution. Thus, the possible arrangements for a display or a sub-section of a display can be determined in advance, as pre-arranged packing patterns for packing, for example, two 6:2s, four 4:3s, three 3:4s and one 2:6, and stored for use in a display or a sub-section of a display as necessary.

Finally, it must be noted that the Original Images 210 from which Graphic Icons 144 are generated will generally be acquired, or captured, by Local System 112 or Server

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System 114 as a graphics file or component of a standard type, such as a GIF or JPEG image or an HTML document or page containing graphic information in the form of GIF or JPEG images, and that the graphic file or component will most usually be a color image in any of several different color information formats. There are many well known and available methods and utilities for converting between GIF and JPEG images and, while it is preferable that Visual Link Capture Engine 138, Visual Links Control 164 and Visual Links Organizer 166 operate with a standard image format, the conversion between one format and another is well understood by those of ordinary skill in the relevant arts and will not be discussed further herein.

As regards color information formats, it is again preferable that Visual Link Capture Engine 138, Visual Links Control 164 and Visual Links Organizer 166 use a standard color format, of which there are several. For example, the 256 color format as used in Microsoft Windows, provides 256 numeric values that may be assigned to corresponding color values wherein the color of each pixel is coded in one byte of information as a RGB (red, green, blue) value and wherein each of the 256 different numeric values may be assigned to a different combination of red, green and blue and thus to a different color. In the "high color" format, each pixel's red, green and blue values are stored in 5 or 6 bit fields of a 16 bit word, and in the "true color" format each pixel's red, green and blue values are expressed directly in three corresponding bytes, giving 256 different possible values each of red, green and blue.

It is also preferable that the color format chosen for use in Visual Link Capture Engine 138, Visual Links Control 164 and Visual Links Organizer 166 be compatible with, for example, Microsoft Windows and Microsoft Windows compatible application programs, such as Netscape and Microsoft Explorer, as it is anticipated that Visual Links 142 will be used and displayed in such an operating environment and with such application programs. For this reason, the presently preferred implementations of Visual Link Capture Engine 138, Visual Links Control 164 and Visual Links Organizer 166 generate, store and display Graphic Icons 144 in a 256 color format that is compatible with Microsoft Windows and Microsoft Windows compatible application programs, such as Netscape and Microsoft Explorer.

In this regard, it should be noted that the 256 color format allows each of the 256 different numeric values that can be expressed in a single byte to be assigned arbitrarily to a different color and that, as a consequence, the 256 colors used in Visual Link Capture Engine 138, Visual Links Control 164 and Visual Links Organizer 166 need not be identical to those assigned to corresponding numeric values in Microsoft Windows and Microsoft Windows compatible application programs, such as Netscape and Microsoft Explorer, so long as the color assignments are sufficiently similar to be visually compatible.

It is possible, however, that a given Original Image 210 will use a 256 color format in which the color/numeric value assignments are visually incompatible with the assignments used in Visual Link Capture Engine 138, Visual Links Control 164 and Visual Links Organizer 166 or in Microsoft Windows and, in these cases, the reassignment of color/numeric values is easily accomplished through a lookup table, as well known in the relevant arts. In a like manner, an Original Image 210 in the high color or true color formats may be readily converted into the chosen 256 color format by determining the bit and byte assignments to red, green and blue value, unpacking the color information from the format into red, green and blue values, and converting the

red, green and blue numeric values into comparable red, green and blue values in the chosen 256 color format, either through lookup tables or, in some instances, by numeric calculation.

Finally in this regard, it should be noted that Visual Link Capture Engine 138 will perform a conversion of the Original Image 210 from the received color format to the chosen 256 color format before the Grayscale Image 212 is generated from the Original Image 210, so that the generation of Grayscale Images 212, and all subsequent operations, including the final generation of the Graphic Icon 144, are performed in a standard manner. As illustrated in FIG. 2A, it should also be noted that it may be desirable to display an image of the Graphic Icon 144 or potential Graphic Icons 144 during operation of Visual Link Capture Engine 138, such as in the implementation of Visual Link Capture Engine 138 used in Local Server 112 where the user is actively interacting with the system. In these applications the presently preferred implementation of Visual Link Capture Engine 138 generates and displays a temporary representation of the Graphic Icon 144 or potential Graphic Icons 144 being considered or generated to the user using the original color format of the Original Image 210, thereby avoiding the need to perform a color format conversion for a temporary display. This image or representation of the Graphic Icon 144 is not stored or saved, however, and only the 256 color format final Graphic Icon 144 is stored for later use.

Lastly, it has been described above that certain implementations of Visual Links Capture Engine 138, such as Visual Links Manual Capture Engine 138M in Local System 112, provide a user with the capability to manually designate a region of Original Image 210 and to convert the designated region of Original Image 210 into a Graphic Icon 144. These implementations of Visual Link Capture Engine 138 preferably utilize the graphic functions and capabilities provided in the operating environment in which Visual Link Capture Engine 138, Visual Links Control 164 and Visual Links Organizer 166 are executing, such as Microsoft Windows. In these implementations, the Visual Links Manual Capture Engine 138M and Visual Links Control 164 provide interfaces to, for example, the Microsoft Windows graphics functions which allow the user to delineate and copy a selectable rectangular region of an image, as well known and understood by those of ordinary skill in the relevant arts.

The selected region is then provided directly to the Visual Link Capture Engine 138 final shaping and sizing functions, described above and described further below, which perform the final steps of generating a Graphic Icon 144 from the selected region. It should be noted that, in certain implementations, it may be desirable to limit the user's selection as regards the size and proportions, or aspect ratios, of the selected region, as described herein above.

3. Detailed Description of Visual Link Capture Engine 138

Having described the overall operation of a Visual Link Capture Engine 138, the following will describe an implementation of Visual Link Capture Engine 138 in greater detail. It will be noted, in this regard, that certain aspects of the structure and operation of Visual Link Capture Engine 138, such as the methods and mechanisms for converting between color formats, generating Grayscale Images 212 from Original Images 210, Filtered Grayscale Images 214 from Grayscale Images 212, Edge Images 216 from Filtered Grayscale Images 214, and Coarse Edge Images 218 from Edge Images 216, will be understood by those of ordinary skill in the relevant arts from the above discussions of an

Visual Link Capture Engine 138 and will accordingly not be described in further detail except as would assist in understanding the present invention.

a. General Description of Visual Link Capture Engine 138 (FIGS. 3A-3H)

Referring now to FIG. 3A1 and 3A-2, the Visual Link Capture Engine 138 is implemented in a presently preferred embodiment in Local System 112 and in Server System 114 as a plurality of program modules residing in Disk Drive 156 or Memory 158 and controlling the operations of Processor 160 to execute the operations described herein on image data residing in Disk Drive 156 or Memory 158. As is well known and understood in the relevant arts, such programs control the operations general purpose Processor 160 and its associated components to operate as one or more dedicated, single purpose mechanisms for performing specific operations that are determined by the programs. Finally, it is assumed for purposes of the present discussions that Server System 210 and Local System 212 are operating under the control of and incorporate the functions and capabilities of a well known and understood operating system such as Microsoft Windows or the general equivalent providing object based processing, object linking, and a variety of functions and operations that are generally available to the program creator, such as graphics editing functions.

The organization of Visual Link Capture Engine 138 as a group of processor control program modules and the functional mechanisms provided by each of the program control modules is illustrated in FIG. 3A and in the exemplary program listings provided in Appendix A.

Before beginning the following detailed description, however, certain aspects of the control program listings provided in Appendix A should be understood, as should certain technical details and assumptions of the following descriptions. First, the control program listings provided include certain versions of the program modules having the extension ".noc". These listings contain alternate implementations of certain program modules that may be used in alternate embodiments of the present invention, and implementations that, for example, provide displays that are not necessary for essential operation of the present invention but that provide displays that may be advantageous for a user or for one who maintains the programs.

For example, there may be implementations in which immediate visual feedback to a user is desired, wherein the Visual Link Capture Engine 138 operates first to select a potential Graphic Icon 144 region of Original Image 210 and presents the selection as a suggestion that the user may often accept without revision. In other instances the user may choose to intervene and, taking some time and care, adjust the source region from Original Image 210 or pick an entirely different source region from Original Image 210. Other alternate embodiments illustrated in these listings utilize red, green blue color information in selection of regions of Original Image 210 to convert to a Graphic Icon 144, again as discussed above.

In addition, the following descriptions assume that Original Images 210 are in the form of ".bmp format" screen captures of a 640-pixel-wide by 480-line-high screen, used in color-mapped mode with 256 colors. In the following examples, only 408 of the 480 lines are actually used, and the colormap is assumed to start in byte [54] of the file, each entry consisting of the four bytes: blue value, green value, red value, zero. It is also assumed that, immediately thereafter (starting in byte [1078]), is the byte-per-pixel data, appearing bottom line first. It is further assumed for purposes of the following discussions that such files, or RAM

bitmap equivalents, will be available without marginal frames, Windows buttons, sliders, etc. In the exemplary embodiment presented herein, such marginalia are stripped by strictly ad hoc means wherein for each image there is side information describing how the picture is to be stripped—by replacing a certain amount of the side material with additional white or black background. It will be understood by those of ordinary skill in the relevant arts that these and other techniques may be used to obtain Original Images 210, and how the system described herein may be readily adapted to other image formats and to other technical assumptions.

As illustrated in FIG. 3A, the control programs comprising Visual Capture Engine 138 include a Main Program 310 which feeds information about images, one at a time, to an image processing mechanism comprised of a Processing Program 312 and a Find Area Program 314. As will be described in further detail below, Processing Program 312 generates Grayscale Images 212 from Original Images 210 and passes Grayscale Images 212 to Find Area Program 314, which generates Filtered Grayscale Images 214, Edge Images 216 and Coarse Edge Images 218 and identifies appropriate areas of Original Image 210 to iconize, that is, to convert into Graphic Icons 144, by searching for locations of bold image, that is, areas of Original Image 210 holding large fonts, photos, logos or combinations of these.

b. Processing Program 312—Grayscale Image Generator 316

For the reasons stated above, and for reasons of speed, the search performed by Find Area Program 314 is based on one or more small versions of Original Image 210 and, in the present implementation, the search is performed using a $\frac{1}{4}$ size gray-scale images, that is, Grayscale Images 212, generated by a Grayscale Image Generator 316 implemented by Processing Program 312, and derivatives of Grayscale Image 212, that is, Filtered Grayscale Image 214, Edge Image 216 and Coarse Edge Image 218, generated by Find Area Program 314.

In alternate embodiments, however, the search process may be performed with images having less or more reductions, depending upon the processing power and speed of Local System 112 or Server System 214 and the time available to process each image. It should be noted, in this regard, that the loss of quality of result appears not be significant for greater reductions in image size as the object of the search is only to identify regions of strong, bold image. Larger images are desirable, however, at least in those implementations providing the user with a display of the proposed Graphic Icon 144 areas under consideration, as providing a more legible and detailed image to the user, and the modifications to Processing Program 312, and to Find Area Program 314, to generate and use images having greater or lesser reductions will be well understood by those of ordinary skill in the relevant arts.

It should also be noted, as discussed above, that Processing Program 312 and Find Area Program 314 may be implemented to use the red, green and blue color components of Original Image 210, as well as the brightness component, in searching for and identifying the areas of bold image suitable for Graphic Icons 144 and, in this implementation, Processing Program 312 may generate, for example, $\frac{1}{4}$ scale grayscale images of the red, green and blue components of Original Image 210 for use by Find Area Program 314, and for display to the user.

It has been found, however, that acceptable results are normally obtained from brightness information alone. As a consequence, in the presently preferred embodiment, Processing Program 312 transforms the RGB (red, green, blue)

Original Image 210 into a grayscale image, as discussed previously, by using a Color Lookup Table 318A to compose a Greyscale Lookup Table 318B which is used, for each pixel in an Original Image 210, to determine greyscale equivalent values for the red, green and blue values associated with each of the 256 numbers. A Grayscale Converter 320, in turn, receives these values and sums these values for 4×4 blocks of Original Image 210 pixels to generate a "Brightness" Value 322 for each 4×4 block of Original Image 210 pixels, the resulting Brightness Value 322 for each block becoming the grayscale value for a corresponding single pixel of the corresponding $\frac{1}{4}$ scale Grayscale Image 312. It will be appreciated by those of ordinary skill in the arts that Grayscale Converter 320 may generate Grayscale Images 212 at sizes other than $\frac{1}{4}$ scale by corresponding changes in the numbers and arrangements of the Original Image 210 pixels selected to form each corresponding pixel of the Grayscale Image 212.

The color component images, that is, Grayscale Images 212R, 212G and 212B are constructed in an analogous manner, but wherein each is generated using only the values for a single corresponding color component, that is, red, green or blue.

c. Mechanisms of Find Area Program 314, Introduction

Once a $\frac{1}{4}$ -size grayscale image Grayscale Image 212 is available from Processing Program 312, Find Area Program 314 provides the mechanisms for performing the operations necessary to generate the remaining images used in finding a Graphic Icon 144 region and constructing a Graphic Icon 144. These operations include:

- (1) Generating a low-pass filtered version, Filtered Grayscale Image 214 of Grayscale Image 212 to blur and diminish any fine text and detail, preferentially leaving any bold image content relatively prominent;
- (2) Generating an Edge Image 216 from Filtered Grayscale Image 214, the Edge Image 216 having high pixel values in regions where Filtered Grayscale Image 214 has certain kinds of structure, and an ultra-low-resolution $\frac{1}{16}$ -size version of Edge Image 216, that is, Coarse Edge Image 218, for use in an initial quick search;
- (3) Replacing each "pixel" of the Coarse Grayscale Image 218 by the sum (modulo register size) of a corresponding rectangle-to-there from 0,0, wherein an arithmetic combination of up to four such entries yields the sum of the corresponding pixels of the corresponding candidate rectangle of the Coarse Grayscale Image 218 and a value representing a "figure of merit" representing, in turn, the proportion of "image edge" in the candidate rectangle;
- (4) Searching essentially the entire Coarse Grayscale Image 218 to find a candidate rectangle of high "merit", that is, high proportion of "image edge", which will serve as the starting point for subsequent enlargement, reduction or modification of the region to be used in constructing a Graphic Icon 144.
- (5) Extending the left, top, right, and bottom sides of the candidate rectangle outward so long as enough edge value, as determined above, continues to accumulate so as to maintain the "figure of merit" of the growing candidate rectangle;
- (6) Adjusting the sides of the candidate rectangle for the purpose of (a) trimming back relatively empty side areas of the image and (b) extending the sides of the candidate rectangle outward where the rectangle side seems to truncate sufficiently strong structural elements in the image; and,

(7) Adjusting the candidate rectangle to obtain a rectangle having one of the selected aspect ratios chosen for efficient tiling of screen space—such as 6:2, 4:3, 3:4 and 2:6, a final adjustment is made and presented as a “fattened” version of the rectangle to iconize.

It should be noted that Find Area Program 314 has identified only the part of the Original Image 210 that is to be re-sized, and perhaps slightly re-shaped, to form the final icon. Visual Link Capture Engine 138 then generates the final Graphic Icon 144 by reference to the Original Image 210 in its original resolution as the source from which the Graphic Icon 144 is generated.

The mechanisms implemented by Find Area Program 314 also address the possible issue that a pair of Graphic Icons 144 from different Original Images 210 may turn out to be sufficiently similar as to be visually confusing. The mechanisms of Find Area Program 314 therefore execute steps 4 through 7 above twice to obtain an alternate region of the Original Image 210 to use as the Graphic Icon 144. On the second pass through the Original Image 210, that is, through the grayscale representations of the Original Image 210, the mechanisms of Find Area Program 314 preclude the area of the first candidate rectangle from becoming any part of the initial candidate rectangle generated by step 4 although, in the present implementation, the second candidate rectangle is not precluded from growing into and including part of, or even all of, the first candidate rectangle. The final output of the Find Area Program 314 mechanisms thereby include four areas, the first candidate rectangle, the first candidate rectangle adjusted to a desirable aspect ratio, the second candidate rectangle, and the second candidate rectangle adjusted to a desirable aspect ratio. The choice between the two candidate rectangles may then be made manually by a user, for example, in a Visual Link Capture Engine 138 as implemented in a Local System 112, or automatically, for example, in a Visual Link Capture Engine 138 as implemented in a Server System 114. In the latter instance, the Visual Link Capture Engine 138 or, more probably, Visual Link Organizer 136, will retain a grayscale image from the newly generated Graphic Icon 144 selection and generation process, such as Edge Image 216 or Coarse Edge Image 218, and will compare the grayscale images of the two candidate rectangles with equivalent stored grayscale images of previously generated Graphic Icons 144.

d. Mechanisms of Find Area Program 314, Detailed Description

1. Lowpass Filter 324

Referring again to FIG. 3A for a detailed description of the structure and operation of the mechanisms implemented by Find Area Program 314, it is shown therein that Visual Link Capture Engine 138 includes a Lowpass Filter 324 connected from Grayscale Image Generator 316 to construct an image, that is, Filtered Grayscale Image 214, from each Grayscale Image 212 wherein the final details of the Grayscale Image 212 image are “smeared”, that is, wherein the high spatial frequency elements are degraded or suppressed, while the low spatial frequency elements, that is, the larger image components, are preserved. In practice this means generating each destination pixel, that is, each pixel of Filtered Grayscale Image 214, from a weighted sum of pixels of the corresponding neighborhood of the source image, that is, Grayscale Image 212. The corresponding program code illustrates two possible smudging filters having, respectively, “radii” of 1 and 2 pixels, which apply the following weighting array to each target array of Grayscale Image 212 pixels to generate a corresponding pixel of Filtered Grayscale Image 214:

			0 0 1 0 0
	0 1 0		0 1 2 1 0
for radius 1:	1 1 1	for radius 2:	1 2 2 2 1
	0 1 0		0 1 2 1 0
			0 0 1 0 0

It will be understood that these low-pass filters are illustrative and representative of a wide variety of sizes and patterns of such arrays of weightings that may be employed in low pass filtering of pixel image data. Many alternative filters will be known and understood by those of ordinary skill in the arts and would be appropriate and, in environments with particular statistically frequent image characteristics, one or another alternative filter may be preferable.

2. Edge Image Generator 326

Edge Image Generator 326, referred to as “make edge pics”, is connected from Low Pass Filter 324 to receive each Filtered Grayscale Image 214 and to construct two “edge” images from Filtered Grayscale Image 214, one being the corresponding Edge Image 216 and the other being the corresponding Coarse Edge Image 218. As has been described, the grayscale image is $\frac{1}{4}$ the linear size of the original image and the edge image is the same size, in pixels, as the grayscale image while the coarse edge image is $\frac{1}{4}$ the linear size of the grayscale image, thereby being $\frac{1}{16}$ the linear size of the original image.

For purposes of the present invention and the present description, the amount or degree of “edge” at a pixel in an image is the degree of coarse structure non-uniformity at that pixel as indicated by the rate at which the coarse structure brightness is changing in some direction. In the present implementation, Edge Image Generator 326 selects a pixel as a target pixel and examines the brightness value, as determined as described previously, a selected distance to either side, or above or below, the target pixel, such as the pixels located two pixels above and below the target pixel, and determines the brightness value of the two pixels and the absolute value of the difference between the two brightness values. Edge Image Generator 326 also determines the absolute value of the difference between the brightness values of the pixels the selected distance to the right and left of the target pixel. The sum of the absolute values of the difference in brightness values is considered the degree of “edge” at the target pixel. Alternatively, the maximum of these values may be used.

This operation may be represented graphically as illustrated in FIG. 3B and expressed as value= $(|2\text{-up}-2\text{-down}|+|2\text{-left}-2\text{-right}|)$.

The image of edge values may be still further improved by increasing the dynamic range, transposing the image to render low values invisible to further computation, and clipping the value to an allowed storage range. It will be realized by those of ordinary skill in the arts, that all of the constants involved are adjustable to yield the best results in a particular universe of images, the values in the present example having been found to be acceptable for World Wide Web pages as typically designed for 256-color colormapped display at 480-by-640 screen resolution.

In an alternate implementation, and instead of the sum of values, Edge Image Generator 326 may be implemented to take the greatest of these differences, or to use diagonally located neighbors, or neighboring pixels at greater or lesser distances away.

Other indications of being on or near an edge of coarse structure may be used instead or in addition to the above

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methods. For example, whether a given target pixel is near by not exactly on a prominent edge or in the middle of a broad line may be detected by analysis of one of the pixel patterns represented by FIGS. 3C, 3D, 3E and 3F and their mirror images and 90° rotations wherein a, b, c and d are the brightness values of pixels 3 to the left, 1 to the left, 1 to the right and 3 to the right of the target pixel, and may be expressed for FIGS. 3C, 3D, 3E and 3F, respectively, as $\max(a,b)-\min(c,d)$, $\max(a,b,c)-d$, $a-\min(b,c,d)$ and $\max(a,d)-\min(b,c)$.

In yet other implementations, Edge Image Generator 326 may also measure for steps up, or down, or at different distances or directions, using the strongest such result, or a combination of the results.

In still other implementations of Edge Image Generator 326 wherein the Visual Link Capture Engine 138 utilizes the color information available from the original image, and as described previously, Edge Image Generator 326 may generate either a single Edge Image 216 incorporating or combining information regarding the three color components, red, green and blue, of an Original Image 210 into a single image, or may generate separate Edge Images 216 and Coarse Edge Images 218 for the three color components. It will be noted in this regard, however, that the use of reduced scale edge image is intended to reduce the volume of data that must be processed while implementations using multiple edge images require significantly increased image processing with consequent increased requirements for processing speed and power or, alternatively, slower processing due to the additional data to be processed. In either implementation, the color information would be used to determine edges of image structures in three dimensional color space. Also as described, Edge Image Generator 326 may use for each entry the maximum or average values of the color component values, or still other combinations. Still other method for mapping strong image features will be useful for yet other particular applications.

Regardless of which method is used, however, to generate Edge Images 216 and Coarse Edge Images 218, the essential principle is to seek a two dimensional image with high values in locations corresponding to prominent structural features in the original image, whether the structural features are line art, such as in logos or large text, or pictures. In general, line art will have localized strong edges in the sense herein while pictures, such as photographs, tend to have continuing undulation of value and, while its edge maxima may be lesser than line art, the average edge value over an area of a picture may be equivalent to that of line art. It should be obvious to one versed in the arts of picture processing that, by adjustment of various parameters of the computation, one can strike a desirable balance between the influence of discrete-valued line art and that of bitmapped-continuous grayscale pictures.

Finally, and in addition to Edge Images 216, Edge Image Generator 326 also, and at the same time as it generates a ¼ size Edge Image 216, generates a linearly 4 times coarser edge image by accumulating the values generated for Edge Image 216 to comprise the pixel values of the corresponding Coarse Edge Image 218, with the accumulated values of four Edge Image 216 pixels comprising a value for a corresponding pixel of Coarse Edge Image 218. It should be noted, in this regard, that while an Edge Image 216 is created as a set of byte sized values, the corresponding Coarse Edge Image 218 is accumulated as a set of 16-bit unsigned word values.

As also illustrated in FIG. 3A, Rectangular Sum Array Generator 328 operates on each Coarse Edge Image 218 to

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generate a corresponding Rectangular Sum Array 330 which, in turn, allows Visual Link Capture Engine 138 to quickly determine, or evaluate, the "edge figure of merit" of any sub-rectangle within Coarse Edge Image 218, that is, the degree of significant image features or structure within any sub-rectangle of a Coarse Edge Image 218 as indicated by the amount of "edge" within the sub-rectangle. It will be noted that any subrectangle must generally have certain minimum dimensions and must generally fall short of the full image dimensions in each direction by at least a small minimum amount.

As illustrated in FIG. 3G, a Rectangular Sum Array 330 contains a Storage Location 332 for and corresponding to each "pixel" of the corresponding Coarse Edge Image 218. Rectangular Sum Array Generator 328 stores, in each Storage Location 332 in Rectangular Sum Array 330, the sum of the values of all pixels of Coarse Edge Image 218 contained within the area bounded by 0,0 as the origin at the upper left corner of the Rectangular Sum Array 330, which corresponds to the upper left corner of the corresponding Coarse Edge Array 218, and the location of the Coarse Edge Image 218 pixel corresponding to the storage location in the Rectangular Sum Array 330. For example, in FIG. 3G Storage Location 332a contains the sum of the values of all pixels in the Coarse Edge Image 218 in the rectangular area bounded on the upper left by the origin (0,0) and on the lower right by the pixel corresponding to the location of Storage Location 332a, Storage Location 332d contains the sum of the values of all pixels in the Coarse Edge Image 218 in the rectangular area bounded on the upper left by the origin (0,0) and on the lower right by the pixel corresponding to the location of Storage Location 332d, and so on. It will be noted, in this regard, that the pixels corresponding to Storage Location 332a, 332b, 332c, and so on are located immediately outside the rectangles of interest defined by the origin an a corresponding one of Storage Locations 332.

The relative value of the total amount of "edge" structure of features appearing in any sub-rectangle of interest in a Coarse Edge Image 218 can thereby be determined from sum values stored in the Rectangular Sum Array 330 as the value $\text{sum } a + \text{sum } d - \text{sum } b - \text{sum } c$ wherein sum a, b, c and d are the stored sum values for the corners of the sub-rectangle of interest. To do so, Rectangular Sum Search Mechanism 334, described below, identifies the Storage Locations 332 corresponding to the pixels in the Coarse Edge Image 218 corresponding to the upper left and lower right corners of the sub-rectangle of interest and subtracts from the sum value stored therein, which is the sum of all Coarse Edge Image 218 pixel values in the rectangle defined by the origin and the pixel corresponding to that Storage Location 332, the sum values stored in Storage Locations 332 corresponding to the upper right, lower left and upper left corners of the sub-rectangle of interest. These Storage Locations 332 corresponding to the upper right, lower left and upper left of the sub-rectangle of interest contain the sums of all Coarse Edge Image 218 pixel values in the Coarse Edge Image 218 sub-rectangles defined by the origin and the pixels corresponding to the upper right, lower left and upper left corners of the sub-rectangle of interest, and therefore contained within the array sum stored in the Storage Location 332 corresponding to the lower right corner of the sub-rectangle of interest and the result of the operation will be the sum of the values of the Coarse Edge Image 218 pixels contained within the sub-rectangle of interest. For example, and referring to FIG. 3G, the sum of the edge values of the Coarse Edge Image 218 pixels in the sub-rectangle defined by Storage Location 332 is deter-

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mined by subtracting from the sum value stored therein the sum values stored in Storage Locations 332a, 332b and 332c, thereby subtracting the sum values of the three sub-rectangles defined by the origin and Storage Locations 332a, 332b and 332c from the sum value stored in Storage Location 332d, thereby generating a sum value for the sub-rectangle defined by the origin and Storage Location 332d.

It will be noted that if the rectangle of interest extends from the left and/or the top of the image, the calculation is correspondingly simplified. That is, if any of the pixels corresponding to Storage Locations 332a, 332b, 332c, and so on are outside of, that is, above or to the left of, the original total image, their rectangle-sum values are not looked up on the sums array, but instead the corresponding value is understood to be zero. Alternatively, the entries of the rectangle-sums array may be stored into and fetched from one position to the right of and below where previously indicated, with the top row and left column filled with zeros. There are then no special cases to consider as a fetch above the top or to the left of the left edge will automatically result in a zero value.

It is apparent that a sum value for any sub-rectangle of a Coarse Edge Image 218 can be quickly and easily determined. It will also be apparent, as will be discussed below, that the sum values for the sub-rectangles of a given Coarse Edge Image 218 can thereafter be used to quickly and easily determine the relative figures of merit of those sub-rectangles wherein a figure of merit essentially indicates whether a sub-rectangle contains enough edge, that is, "sum", in relation to the size of the sub-rectangle.

It should be noted that sum values may exceed the maximum value that may be held in a machine word. This is generally acceptable, however, provided that overflow-traps or other such cautionary hardware or software features are not activated in the system in which Visual Link Capture Engine 138 is executing, as the sum modulo 2-to-the-power-of-bits-per-word will be stored, that is, the sum starts counting over, e.g. 65534, 65535, 0, 1, 2, . . . 2. Also, in most computer systems, the above arithmetic $d+a-b-c$ will be performed modulo the same number, yielding the desired value, provided only that the highest sum that is expected is lower than the modulus, in which case the capture engine as implemented could add results from several such sub-parts of the indicated rectangle so long as no part's sum exceeds the maximum possible such sum.

Finally, the search for the optimum candidate rectangle, described below, can be exhaustive, and involves tests on thousands of possible rectangles. It will be apparent, however, that each test is relatively fast to perform, involving calculations of only a few values each. In addition, in the present implementation the conversion of a Coarse Edge Image 218 to a Rectangular Sum Array 330 is performed in a very simple and straightforward way, computing first the top row and the left column, then filling each remaining Storage Location 332 in the remainder of the array from the values immediately above, immediately to the left, and immediately diagonally above and to the left.

3. Rectangular Sum Search Mechanism 334

As illustrated in FIG. 3A, Rectangular Sum Search Mechanism 334, implemented as "find_start_rect" searches the Rectangular Sum Array 330 corresponding to a Coarse Edge Image 216 of an Original Image 210 for candidate regions to be potentially used in generating a Graphic Icon 144 and determines a "best" first approximation to an acceptable Graphic Icon 144 region in the Original Image 210 as a Candidate Region 336A.

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In this regard, in the present implementation of Rectangular Sum Search Mechanism 334 the figure of "merit" or "assurance" of each candidate rectangle is determined, as described previously, first, on the average "edge" values of the pixels, that is, on the values of the pixels of Coarse Edge Image 218 as represented by the sum values stored in the corresponding Storage Locations 332 of Rectangular Sum Array 330, for each potential sub-rectangle of Rectangular Sum Array 330, and, as a secondary factor, on the size of each candidate rectangle, for the reason that a very small rectangle can easily but not meaningfully exceed larger rectangles as regards the average "edge" value of the pixels represented therein. Stated another way, a larger region or rectangle that includes a smaller region or rectangle of higher average "edge" value is probably a meaningful enlargement of the smaller region or rectangle.

In an alternate embodiment of Rectangular Sum Array Generator 328, the figure of "merit" or "assurance" of a rectangle is implemented as the average edge value of the rectangle, as determined by the value sums stored in Rectangular Sum Array 330, plus a constant times the perimeter of the rectangle in pixels. Clearly a variety of such alternate evaluations of "merit" or "assurance" might be used. The principle implemented in the presently preferred embodiment of Rectangular Sum Array 330, however, is that for rectangles having approximately equal values of "merit" or "assurance", the larger the rectangle the better. In the reverse, for rectangles of equal size, the greater the amount of edge (bold structure), the better.

Having identified a "best" Candidate Region 336A, Rectangular Sum Search Mechanism 334 in the presently preferred embodiment of Visual Link Capture Engine 138 then repeats the search procedure to determine at least a second Candidate Region 336B, thereby determining and identifying at least two candidate rectangles from each Original Image 210, as previously described. As has been and will be discussed, the identification of two or more Candidate Regions 336 thereby allows Visual Link Capture Engine 138 or the user to select the Candidate Region 336 most visually representative of the original image or to compare the Candidate Regions 336 to previously existing Graphic Icons 144 and to select and retain the Candidate Region 336 most visually distinct from all previously existing Graphic Icons 144 without having to repeat the entire identification process from the beginning.

In the presently preferred implementation, Rectangular Sum Search Mechanism 334 is not permitted to retrace the search through the image by which Candidate Region 336A was identified when locating and identifying Candidate Region 336B. Rectangular Sum Search Mechanism 334 is thereby prevented from identifying the same or nearly the same region of the image as Candidate Regions 336A and 336B as it is desirable to locate two visually distinguished Candidate Regions 336. As such, and for this reason, Rectangular Sum Search Mechanism 334 is designed so that Candidate Region 336A is designated as a forbidden area of the image and the search operation performed by Rectangular Sum Search Mechanism 334 is accordingly constrained by the designation of Candidate Region 336A as a forbidden area to avoid overlap with a forbidden area if in fact, a Candidate Region 336A has been previously identified.

It will be appreciated by those of ordinary skill in the arts that there are a number of methods for constraining the Rectangular Sum Search Mechanism 334's search for Candidate Region 336B to prevent overlap, or at least significant overlap, with a Candidate Region 336A. For example, a

second rectangle will not overlap a first rectangle if and only if the second rectangle is completely above, or completely to the left of, or completely to the right of, or completely below the first rectangle. Rectangular Sum Search Mechanism 334 may be implemented, however, to be constrained from considering any rectangular region of Rectangular Sum Array 330 wherein one or both of the upper left or lower right corners of the rectangular region fall within the rectangular region of Rectangular Sum Array 330 comprising Candidate Region 336A. However, while a constraint with respect to both corners will prevent any overlap between Candidate Regions 336A and 336B, a constraint with respect to only one corner would permit at least some overlap, unless further constraints are imposed on the possible locations of a Candidate Region 336B corner within Candidate Region 336A.

The present implementation of Rectangular Sum Search Mechanism 334, is not constrained however, so that the fully developed Candidate Region 336B will not overlap the fully developed Candidate Region 336A, as the full extents of Candidate Regions 336A and 336B will not be known until the regions are fully developed, as described below. As such, an overlap may occur between the fully developed Candidate Regions 336A and 336B, particularly when there is no acceptable but completely separate second Candidate Region 336B.

Finally, it should be noted that search is performed by Rectangular Sum Search Mechanism 334 in what may be referred to as " $\frac{1}{16}$ scale space", that is, within the dimensions and coordinates of Coarse Edge Image 218 and Rectangular Sum Array 330. As such, Rectangular Sum Search Mechanism 334, having identified Candidate Regions 336A and 336B in terms of the coordinates and dimensions of Coarse Edge Image 218 and Rectangular Sum Array 330, transforms the coordinates defining the bounds of Candidate Regions 336A and 336B, that is, the coordinates of the corners of Candidate Regions 336A and 336B into corresponding coordinates in the " $\frac{1}{4}$ scale space" of Grayscale Image 212, Filtered Grayscale Image 214 and Edge Image 216 by, in effect, magnifying the coordinates of Candidate Regions 336A and 336B by a factor of four. The final results of the search are thereby reported in " $\frac{1}{4}$ scale space" as Initial Candidate Regions 336AI and 336BI for final selection and adjustment of the selected region or regions as Graphic Icons 144, as described below.

4. Grow Rectangle Mechanism 338

Grow Rectangle Mechanism 338, as implemented by "grow_rect", cyclically and iteratively attempts to "grow" each of Initial Candidate Regions 336AI and 336BI by extending each side of each of Initial Candidate Regions 336AI and 336BI outward. A "figure of merit" or "assurance" for each of Initial Candidate Regions 336AI and 336BI is evaluated after each such extension, with the purpose of searching for larger Candidate Region 336A and 336B rectangles with higher figures of "merit" or "assurance".

In the initial steps of the "growing" process, a few possible extensions are considered to the right, then upward, then to the left, and then downward. Then, and dependent upon the results of the initial attempts, progressively larger ranges of extension are attempted and evaluated. As a result of this process, the extents of either or both of Initial Candidate Regions 336AI or 336BI may be extended to "bridge over" possible "blank" areas, that is, adjacent areas having little or no significant visual structures or features, if and when there are nearby areas having significant and presumably related visual structures or features that may be

preferably incorporated into either or both of Candidate Regions 336A or 336B.

As indicated in FIG. 3A, Grow Rectangle Mechanism 338 may perform this "growing" operation using Edge Image 214 or Coarse Edge Image 216 or Rectangular Sum Array 330. As has been described previously, both Coarse Edge Image 218 and Edge Image 216 contain numeric values for each pixel therein that represent the "edge" characteristics or properties of the pixels while Rectangular Sum Array 330 contains an accumulated value representing the cumulative totals of edge information for the rectangles defined by each pixel in Coarse Edge Image 218. In addition, the coordinates and dimensions of Initial Candidate Regions 336AI and 336BI have been determined by Search Rectangle Mechanism 330 in terms of the " $\frac{1}{4}$ scale" coordinates of Edge Image 216 and in terms of the " $\frac{1}{16}$ scale" coordinates of Coarse Edge Image 218 and Rectangular Sum Array 330.

The operation of Grow Rectangle Mechanism 338 will therefore be essentially the same whether Grow Rectangle Mechanism 338 operates in " $\frac{1}{4}$ scale" space or in " $\frac{1}{16}$ scale" space, although the present implementation of Grow Rectangle Mechanism 338 operates in " $\frac{1}{4}$ scale" space. In either implementation, Grow Rectangle Mechanism 338 will determine an initial figure of "merit" or "assurance" for each of Initial Candidate Regions 336AI and 336BI wherein the figure of "merit" or "assurance" represents the amount of edge information initially within the rectangles defined by Initial Candidate Regions 336AI and 336BI. This information is already available for " $\frac{1}{16}$ scale" space from the operations of Search Rectangle Mechanism 330, as described above, and an equivalent figure of "merit" or "assurance" can be determined from the information stored in Edge Image 214 for " $\frac{1}{4}$ scale" space.

Grow Rectangle Mechanism 338 will then extend each of Initial Candidate Regions 336AI and 336BI by a predetermined amount in an initial predetermined direction, such as one pixel to the right, and will evaluate the figure of "merit" or "assurance" for the resulting extended rectangles. This process will be repeated by successive amounts, and in different directions, for amounts of increase and directions for which the figure of "merit" or "assurance" of an extended rectangle remains approximately the same as the initial value or increases. If the figure of "merit" or "assurance" declines for the smaller initial extensions, the process will be repeated for greater extensions, such as two, four or eight pixels in each direction.

The final result of the operations of Grow Rectangle Mechanism 338 are then provided as Grown Candidate Regions 336AG and 336BG.

5. Edge Adjuster 340

Edge Adjuster 340, implemented in Appendix A as "adjust_edges", operates upon Grown Candidate Regions 336AG and 336BG to perform a subsequent adjustment of the sides of Grown Candidate Regions 336AG and 336BG. As has been describe, Edge Adjuster 340 "sims away" pixels along the sides of the rectangles having relatively little visual structure or features and extends the sides of the rectangles where visual or structural features extend across the sides of the rectangles, thereby incorporating the continuing visual structures or features within the rectangles, and generating Edge Adjusted Candidate Regions 336AE and 336BE.

Edge Adjuster 340 operates according to the criteria described previously to cyclically and iteratively adjust the boundaries of Grown Candidate Regions 336AG and 336BG by one-pixel adjustments, either inwards or outwards on each edge, to incorporate the entirety of such features as

pictures and logos within the rectangles, even when such extensions do not meet the edge information figure of "merit" or "assurance" criteria used by Search Rectangle Mechanism 330 or Grow Rectangle Mechanism 338.

As the criteria used by Edge Adjuster 340 has been discussed previously, Edge Adjuster 340 will not be discussed in further detail herein. It will be apparent to those of ordinary skill in the relevant arts, however, that many methods may be used to adjust the regions enclosed in either or both of Grown Candidate Regions 336AG and 336BG to include visual features and structures that extend outside the rectangles, or to eliminate peripheral areas of the rectangles having little visual structure or features. The essential aspect of the operation of Edge Adjuster 340 is to find at least one nucleus area containing strong image material and to adjust its sides, or boundaries, so as to differentiate visually objects contained therein from extraneous areas that ought not to be included. For this purpose, Edge Adjuster 340 operates to grow or enlarge the initial candidate area so as to include an agreeable relationship between coarse structure and size and to adjust the sides of the initial candidate area in or out to appropriate cut-off points with the goal of totally including internal visual objects while excluding nearby parts of external visual objects.

It should be noted that the initial rectangles of Candidate Regions 336A and 336B are determined in " $\frac{1}{16}$ scale" space, as described above, and that all subsequent operations, such as growing Candidate Regions 336A and 336B and adjusting the sides of Grown Candidate Regions 336AG and 336BG are performed in " $\frac{1}{4}$ scale" space in the present implementation of Visual Link Capture Engine 138. As such, the granularity of the grown and adjusted Candidate Regions 336A and 336B will be limited to the granularity of " $\frac{1}{4}$ scale" space. In alternate embodiments, however, and with additional computing time and more storage allotted to image arrays, Visual Link Capture Engine 138 can maintain and use half-size and/or full size arrays, alternatively or subsequently, and perform these operations in " $\frac{1}{2}$ scale" or "full scale" space, yielding a 2 pixel or single pixel granularity for the final growing and adjustment of Candidate Regions 336A and 336B. While this increase in resolution, or refinement of granularity, may result in ultimately finer adjustments, the benefit may be marginal given that the location of coarse structure is the essential goal.

6. Aspect Ratio Adjuster and Candidate Comparator 342. Finally, Aspect Ratio Adjuster and Candidate Comparator 342, "fix_aspect_ratio" accepts proposed source image areas Edge Adjusted Candidate Regions 336AE and 336BE and enlarges Edge Adjusted Candidate Regions 336AE and 336BE horizontally or vertically to conform to one of a set of desirable aspect ratios. As described previously, in the present example those aspect ratios are selected as 6:2, 4:3, 3:4 and 2:6, including a border area.

Aspect Ratio Adjuster and Candidate Comparator 342 also compares the ratio adjusted Edge Adjust Candidate Regions 336AE and 336BE, in the manner previously described, to select between the candidate regions, and compares the selected ratio adjusted candidate region with previously generated Graphic Icons 144, if any, to determine whether the selected candidate region is too similar to a previously existing Graphic Icon 144, reverting to the unselected candidate region if too similar a match is found with a previously existing Graphic Icon 144, or even reinitiating the generation process if necessary. As has been described elsewhere herein, and for other processes, the selection process may be performed automatically by the capture engine, for example, by performing an overall comparison

between two Graphic Icons 144, or manually by displaying the Graphic Icons 144 to a user for selection at the user's decision.

As has also been described, the adjustment is performed by means of selected intermediate ratios used as aspect ratio range dividers. For example, if a Candidate Region 336 height-to-width ratio is less than 4:3 and greater than 3:4, and taller than wide, the Candidate Region 336 is "stretched" vertically to an aspect ratio of 4:3. Otherwise, if the ratio lies within this range the Candidate Region 336 is stretched horizontally to an aspect ratio of 3:4, as the applicable aspect ratio range divider in this example occurs at 1:1. Other range dividers of the present example have been chosen to occur at 9:5 and 5:9.

Many aspect ratios and aspect ratio range dividers are possible, depending upon the number and range of acceptable aspect ratios for Graphic Icons 144. For example, another set of icon aspect ratios might be 6:2, 5:3, 4:4, 3:5 and 2:6, which would provide more advantageous "fits" for certain ranges of icons, but would result in significantly more icon shapes and greater consequent difficulty in organizing the icons tightly in a display. Still other sets of acceptable sizes and shapes are possible, including those based on non-rectangular division of the ultimate display space.

As has been described, and will be understood by those of ordinary skill in the relevant arts, many methods and combinations of methods may be used to "stretch" or otherwise adjust the aspect ratios of Candidate Regions 336 to form Graphic Icons 144 or to "fit" the Candidate Regions 336 into the selected aspect ratios when a given Candidate Region 336 does not fit into one of the selected aspect ratios. For example, any extra space around a Candidate Region 336 after it has been fitted into a selected aspect ratio may be left blank in the display, which may result in a disorderly appearing display which, however, may be acceptable. In another implementation, the Candidate Region 336 may be "stretched" in the needed direction, horizontally or vertically, as stretches of up to 5% will scarcely be noticed and stretches of up to 10% or even more will probably not be objected to by a user. In yet other implementations, the top or bottom or sides or any combination thereof may be "trimmed" or extended as necessary, perhaps using one of the methods described herein above. In another method, the Candidate Region 336 may be extended until the region reaches a recognizable background color, and thereafter filled with that background color, rather than including accidental and inappropriate parts of neighboring objects.

The operation of Aspect Ratio Adjuster and Candidate Comparator 342 has been described further herein above, and an implementation of Aspect Ratio Adjuster and Candidate Comparator 342 as "fix_aspect_ratio" and will thereby be well understood by those of ordinary skill in the arts. As such, Aspect Ratio Adjuster and Candidate Comparator 342 will not be discussed further herein or, and for the same reasons, will be the operation of various implementations of Visual Link Capture Engine 138 in selecting between the two Graphic Icons 144 resulting from the operation of Aspect Ratio Adjuster and Candidate Comparator 342 on Edge Adjusted Candidate Regions 336AE and 336BE. In this respect, however, it will be noted that the object in selecting between the two Graphic Icons 144 is to determine whether a first one of the two Graphic Icons 144 is sufficiently similar to a Graphic Icon 144 already in the current library or set of Graphic Icons 144 to be visually confusing to a user and, if so, whether the second candidate Graphic Icon 144 may be more suitable as being more

visually distinctive to a user with respect to the already existing Graphic Icon 144.

7. Iterative Method For Finding A "Best Rectangle"

It must be noted that the "best rectangle" of an original image for use in creating a Graphic Icon 144 may also be found by means of a reiterative method using essentially the same mechanism and data structures as described above, but in a reiterative manner using a plurality of progressively coarser edge images. Although requiring the construction of additional edge images in the same manner as described above, this method involves simpler steps and is thereby faster in at least some implementations.

According to the alternative, recursive method, the capture engine develops a quarter-size grayscale image as described above, for example, 192 pixels wide by 144 pixels high as these dimensions are multiples of 2, and from that grayscale image develops a low-pass filtered image and a first edge image. The capture engine then generates a sequence of progressively coarser edge images, each being reduced in resolution by 2 with respect to the previous edge image of the sequence. This, for example, will result in a 192x144 edge image, referred to as the first edge image, a 96x72 second edge image, a 48x36 third edge image, a 24x18 fourth edge image, and a 12x9 fifth edge image.

The capture engine will then perform an exhaustive search as described above to find the best subarea of the fifth, and smallest, edge image that contains none of the fifth edge image edge pixels and is at least 3 pixels wide by 2 pixels high. The coordinates of the best rectangle of the fifth edge image are then reflected back to the fourth edge image and 81 variants of that "best rectangle" as reflected back to the fourth edge image are tested to find the "best" rectangle variant of the fourth edge image corresponding to the "best" rectangle of the fifth edge image. In this regard, the quantity 81 represents 3 variants on each possible edge adjustment of the "best" rectangle from the fifth edge image, that is, with each edge being pushed out one pixel, being left alone, or being pulled in one pixel.

The coordinates of the "best" rectangle of the fourth edge image that is a variant of the "best" rectangle of the fifth edge image are then reflected into the third edge image to find the corresponding rectangle therein. 81 variants of the "best" fourth edge image rectangle that is a variant of the "best" fifth edge image rectangle are again examined in the third edge image, again by one pixel adjustments of the edge of the rectangle in the third edge image, until the "best" third edge image rectangle is found.

This process is repeated for successive edge images up through the sequence, moving to progressively higher resolution edge images, until a final "best" rectangle is found.

It will be appreciated by those of ordinary skill in the relevant arts that this alternative method thereby achieves a definition of a subrectangle for use in creating a Graphic Icon 144 by successive approximation. It will also be appreciated that this method can, in principle, define any possible subrectangle of the largest edge image, except those containing the very edge row of pixels, with tests on only a few hundred mostly smaller rectangles.

4. Detailed Description of Visual Links Organizer 166 (FIG. 4A-4I)

As has been discussed briefly above, a common problem in designing computer/user interfaces is to arrange the non-overlapping placement or organization of objects, such as conventional icons, Graphics Icons 144 or photographs of electronic mail recipients, of various sizes and/or shapes in a display space, such as a display window, in an efficient

manner. A further aspect of this problem in instances wherein there are a large number of such displays of objects is to provide a selection of display arrangements or organizations for each given number of objects of given sizes and shapes to allow a variety of mutually distinctive display arrangements for each given number of objects of given sizes and shapes.

According to the present invention, Visual Links Organizer 166 provides a solution to these problems by providing a mechanism for efficient packing any arbitrary collection of Graphic Icons 144 having various dimensions and aspect ratios objects, or other visual display objects such as conventional icons or photographs of electronic mail recipients of various sizes and/or shapes into a display area.

It has been noted in the previous discussions of Visual Links Organizer 166 that the "tiling" of many icons of various sizes and shapes, as was illustrated in FIG. 2B, is a "bin-packing" problem of tiling geometry and that, in certain implementations, such as those with a relatively small number of icons per display, for example, 10 to 20, Visual Links Organizer 166 may be implemented by computing and tabulating at least one arrangement for each maximally achievable icon population distribution. Thus, the possible arrangements for a display or a sub-section of a display can be determined in advance, as pre-arranged packing patterns for packing, for example, two 6:2s, four 4:3s, three 3:4s and one 2:6, and stored for use in a display or a sub-section of a display as necessary.

Therefore, and as will be described in the following Visual Links Organizer 166 performs this function by pre-computing and concisely storing tabulated guides or tables for organizing visual objects, such as conventional icons, Graphics Icons 144 or photographs of electronic mail recipients, of various sizes and/or shapes in a display space so as to speed and simplify the solution to specific object layout problems as they arise. Despite the conciseness of these tables, however, Visual Links Organizer 166 provides a wide variety of answers to each given problem, that is, a variety of visual object organization layouts for each given number of objects of given sizes and shapes.

a. General Description of Visual Links Organizer 166

As has been discussed with reference to FIG. 1A, Local System 112 includes a Visual Links Control 164 and a Visual Links Organizer 166, both of which are associated with and operate in association with Web Access Program 162, and associated with Visual Links Control 164 and Visual Links Organizer 166 is a Visual Links Library 168 for storing Visual Links 142, which include Graphic Icons 144. As discussed, Visual Links Control 164 operates to interface and integrate Visual Links 142, Visual Links Organizer 166 and Visual Link Capture Engine 138, if present, into Web Access Program 162, and allows a user to access the target of a Visual Link 142 and to save a Visual Link 142 in Visual Links Library 168 or a file. Visual Links Organizer 166, in turn, allows a user to create and edit Visual Links 142, to store Visual Links 142 in Visual Links Library 168, and to otherwise manage Visual Links 142 and Visual Links Libraries 168. Visual Links Organizer 166, which will be described in detail further below, also allows a user to organize the display of Visual Links 142 in a Visual Links Library 168, for example by displaying Graphic Icons 144 in one or more display windows or areas.

Referring to FIGS. 1A and 4A, it is illustrated therein that a the Visual Links Organizer 166 of a Local System 112 or, for example, a Server System 114, may include a Layout Generator 410, a Layout Table 412 and a Display Generator 414, for respectively generating and storing display layouts

and generating displays of visual objects, depending upon the particular implementation and function of a given specific embodiment of Visual Links Organizer 166. In many Local Systems 112, for example, as illustrated in FIG. 1A, the Visual Links Organizer 166 may include only a Layout Table 412 and a Display Generator 414 and the layouts may be provided from another system, such as another Local System 112 or a Server System 114 to be stored in the Layout Table 412 for use in the Local System 112.

In this regard, Layout Generator 410 is responsive to Layout Definition Inputs 416, each including a Display Space Definition 418a containing a specification of a selected display area, such as 12 units by 12 units, and a Visual Object Definition 418b containing a specification of the numbers, sizes and aspect ratios of visual objects to be displayed therein, for generating one or more corresponding Layouts 420 which are encoded as Plans 424, each containing a description of a layout, or organization, of the specified visual objects in the specified display space. Plans 424 are then stored in Layout Table 412, where they may be accessed by Display Generator 414 to generate a Visual Display 426 of a specified display area containing a set of identified specific Graphic Icons 144 or other visual objects conforming with the corresponding Visual Object Definition 418b as to number, size and aspect ratio.

Display Generator 414 is, in turn, responsive to Display Definition Inputs 428A containing a Display Space Definition 418a provided, for example, by a user or by another program operating through Visual Links Control 164 or from a Visual Link Display Memory 428B associated with Visual Links Organizer 166 for storing information relating to the display capabilities of Local System 112, and specifying the display area to be used for displaying a set of Graphic Icons 144 or other visual objects. Display Definition Inputs 428A also include a set of Visual Object Identifiers 430, such as pointers to specific Graphic Icons 144 residing in Visual Links Library 168 and identifying members of a set visual objects conforming with the corresponding Visual Object Definition 418a that are to be displayed in the defamed display area. In this regard, Visual Object Identifier 430 may be provided by a user of another program or, more probably from Visual Links Display Memory 428B because a user will generally use Visual Links Organizer 166 to organize Visual Links 142 into groups of related Visual Links 142 and will store the identifications of the Visual Links 144 as groups in Visual Links Display Memory 428B. Display Generator 414 is then responsive to Display Definition Inputs 428 for indexing Layout Table 412 with Display Definition Inputs 428, reading one or more corresponding Plans 422 therefrom, and generating a Display 428 of the identified Graphic Icons 144 or other visual objects in the specified display area and according to the selected Plan 424.

It will be appreciated by those of ordinary skill in the relevant arts that the component parts of a given implementation of Visual Links Organizer 166 may depend upon the intended purpose and functions of that implementation of Visual Links Organizer 166. For example, and as illustrated in FIG. 1A, an implementation of Visual Links Organizer 166 residing in a Local System 112 may include only Display Generator 414 and one or more Layout Tables 412 as the Layout Tables 412 may be provided from an external source, such as downloaded from a Server System 114 or a Web Site 118 or otherwise provided with Visual Links Organizer 166 on initial installation of Visual Links Organizer 166 or later loaded from disk. In other instances, however, an implementation of Visual Links Organizer 166

residing on a Local System 112 may include Layout Generator 410 to allow the user of the Local System 112 to generate Plans 422 at will. In a like manner, an implementation of Visual Links Organizer 166 residing on a Server System 114 may include Display Generator 141, one or more Layout Tables 412 and Layout Generator 410, thereby allowing the operators of the Server System 114 to generate Displays 428 of Graphic Icons 144 residing in Visual Links Library 168 for use by the operators of Server System 114 in managing the creation an storage of Visual Links 142 therein, as well as generating Layout Tables 412 for local use in Server System 114 and possibly for downloading to Local Systems 112. In yet other implementations, a system for generating Layout Tables 412 may include only Layout Generator 410 and the Layout Tables 412 generated by Layout Generator 410, with the Layout Tables 412 being provided elsewhere, such as to a Local System 112 or a Server System 114 for use therein.

It will also be understood by those of ordinary skill in the relevant arts that the applications of the various implementations and embodiments of Visual Links Organizer 166 are not limited only to World Wide Web systems and the organization and display of Graphics Icons 144 but may be used in any application requiring the non-overlapping placement or organization of objects, such as conventional icons or photographs of electronic mail recipients, of various sizes and/or shapes in a display space, such as a display window, in an efficient manner. The implementations of Visual Links Organizer 166 may therefore be used, for example, to organize and display graphic representations or icons representing application programs, as in Microsoft Windows Program Manager, or to organize and display graphic representations or icons of files, as in Microsoft Windows File Manager, or to organize and display icons or graphic representations, such as photographs, of recipients or locations in an electronic mail system.

b. Definitions and Terms

The operation of Layout Generator 410 may be illustrated with reference to FIG. 4B, which illustrates an exemplary Layout 422 generated by Layout Generator 410. In this example, the Display Space Definition 418a specifies a display area of 12 by 12 units and Visual Object Definition 418b has specified that the visual objects to be displayed therein shall include three 6-high by 2-wide Graphic Icons 144, five 4-high by 3-wide Graphic Icons 144, two 3-high by 4-wide Graphic Icons 144, and one 2-high by 6-wide Graphic Icon 144, with 12 square units of unused space occurring in the resulting Layout 422.

Before proceeding with the detailed description of Visual Links Organizer 116, certain of the terms and expressions used in the following descriptions will be defined, and illustrated by reference to FIG. 4B. These terms and expressions include:

(a) Screen: a rectangular space allotted for tiling with icons.

(b) Coordinates (of an icon): the coordinates of a Graphic Icon 144 or other visual object in a screen is described by the coordinates stating horizontal and vertical positions, in that order, of the top left corner of the visual object, using the horizontal and vertical coordinates 0, 1, . . . ,9,A,B, . . . Z having an origin at the top left corner of the screen, as illustrated in FIG. 4B.

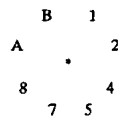
(c) Units: the basic dimensional granularity of visual object, such as Graphic Icons 144, and screen layouts.

(d) Icons: generic term for Graphic Icons 144 or other visual objects forming the tiles for filling space, illustrated in FIG. 4B for Graphic Icons 144 having aspect ratios of 6x2, 4x3, 3x4, and 2x6 units;

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(e) Layout: a specific geometric configuration of icons in a screen, referred to herein as a Layout 422.

(f) Orientations, rotations and reflections: an angular position, orientation rotation in a screen with respect to the horizontal and vertical axes of the screen and labeled with respect to the 1:00 o'clock position, using a clock face as a coordinate system according to the convention



so that orientation "8" specifies a reflection through a 45 degree backslash angle.

(g) Icon set: a specified group of icons having defined aspect ratios, for example, the set illustrated in FIG. 4B is {6x2, 4x3, 3x4, 2x6} and an alternative set might be {6x2, 5x3, 4x4, 3x5, 2x6}.

(h) Fault: a cutline across a layout which divides it into two rectangles without intersecting any icons.

(i) Subrectangle: a proper subarea of a layout containing completely some subset of its icons and no parts of other icons.

(j) Subsquare: a square subrectangle.

(k) Types: the sizes and shapes of the icon set as identified by the heights of the icons in the set, so that the types of the icons illustrated in FIG. 4B are 6, 4, 3, 2.

(l) Population (of a layout): the number of icons of various sizes/shapes as specified by the number of each type stated in an understood order, such as decreasing height, so that the population of the layout illustrated in FIG. 4B is specified as 3521, representing 3 6x2 icons, 5 4x3 icons, 2 3x4 icons, and 1 2x6 icon, wherein it is understood that a population may be hypothetical and may, in fact, be unrealizable in a certain size of screen, so that the population 6000 cannot be realized by a layout for an 11x11 screen even though there would seem to be sufficient space for the icons in the screen.

(m) Subpopulation (of a population): a set of icons for which the count for each type therein is not greater than the count for corresponding type in the population of which the subpopulation is a member, and which is lesser for at least one type, so that the set 2421 is a subpopulation of the population 3521.

(n) Maximal population: for a specific screen size and shape, a layout-realizable population such that the increase by one of any of its icons types yields an unrealizable population for that screen size and shape.

(o) Plan: a notation, referred to herein as a Plan 424, for a layout for understood screen size/shape, such as the 12x12 screen illustrated in FIG. 4B and wherein the population and sequence of top left coordinate locations of the icons are ordered by type, so that the plan for the example of FIG. 4B is written as

3521 00 20 06, 90 94 36 66 98, 40 43, 2A,

with the understanding the commas and spaces are not required, wherein the first number, which contains a digit for each type of icon, such as 3521, defines the population of the screen by number of each type of icon, such as 3 6x2 icons, 5 4x3 icons, 2 3x4 icons, and 1 2x6 icon in the present example, and each set of two digit numbers defines, for each type of icon, the coordinates of the upper left corners of the icons of the corresponding type, so that 00 20 06 specifies the coordinates of the upper left corners of the 6x2 icons, and

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so on. Further examples of a tabulated set of layouts is illustrated in Appendix B.

(p) Inversion (of a screen's aspect ratio): a reinterpretation of a plan, such as 6x7, to its inverted aspect ratio, such as 7x6, by 45-degree-backslash flip and performed by exchanging the interpretation of its x and y dimensions and interchanging all designations of aspect ratios stated for the original screen, such as 6x2<-->2x6 and 3x4<-->4x3, so that the two plans are inversions of each other, as illustrated in FIGS. 4C and 4D.

According to the present invention, it is necessary to generate and save only plans for wider-than-high and square screens for icon sets that contain all icons in both orientations as the corresponding higher-than-wide, or wider-than-high, screens and the inversions of square screens may be generated by inversion of the generated screens.

(q) Sublayout: a subset of a layout wherein the population of the subset is a subpopulation of the layout so that the layout may contain the population of the sublayout by occupying a part of the icon locations in the layout with the icons of the population of the sublayout. For example, the population 3421 is a subpopulation of the population 3521 and can be arranged in the 3521 plan by using any four of the five locations designated for 4x3 icons in the 3521 plan. This principle is related to but different from the principle that a set of one or more different plans may often be generated from an original plan having space not occupied by icons by vertical or horizontal lateral movement, that is, sliding, of one or more of the icons of the original plan. Therefore, by visual examination of FIG. 4A it can be seen that at least four additional 3521 layouts may be generated from the 11x12 layout illustrated therein by horizontal movement, or sliding, or an icon and that more may be generated by horizontal movement of combinations of two or more of the icons therein.

d. The Generation of Plans by A Layout Generator 410

Referring to FIG. 4E-1, therein is illustrated the process executed by Layout Generator 410 in generating at least one Layout 422 and a corresponding Plan 424 for each specified screen, such as 6x6, 6x7, 6x8, . . . 7x7, 7x8, . . . 10x6, . . . 11x12, . . . and so on. The following will assume that, in the presently preferred embodiment of Layout Generator 410, only one Plan 424 is stored for each population of Graphic Icons 144 or other visual objects to be displayed therein, although it will be understood that in other implementations a plurality of Plans 422 may be generated and stored for each combination of a screen size and aspect ratio and population of Graphic Icons 144 or other visual objects to be displayed therein. It will be understood by those of ordinary skill in the relevant arts that the following process and mechanism may be applied to the arrangement or layout of any form of visually displayable objects, such as conventional icons, graphic images of all forms and images such as photographs, in any form of display and is thereby not limited in use only to the layout of Graphic Icons 144. As such, it will be understood that in the following the term "graphic icon" is intended to refer to any form of visually displayable object occupying a rectangular space.

As illustrated in FIG. 4E, therefore, the process executed by Layout Generator 410 is generating Layouts 420 and Plans 422 is performed by a Layout Generator 410 mechanism including a Possible Layout Generator 429. Possible Layout Generator 429 generates, for each screen size and aspect ratio and for each maximal population of Graphic Icons 144 or other visual objects, as specified by the numbers and types of visual objects, as, for example, by a Display Space Definition 416 and a Visual Object Definition

420, generate all possible Layouts 420 for a combination of screen and population by trying all possible locations of the various types of icons of the specified population in the specified screen, disallowing icon overlaps, and consider as candidates the endpoint Layouts 420 that can accommodate no further icons, that is, are filled by the specific population.

As indicated in FIG. 4E-1, Possible Layout Generator 429 includes a Search Forward Mechanism 431a which searches forward on each placement of each Graphic Icon 144 or other visual object of the current population in the current screen until possibilities have been considered, wherein a search forward is an attempt to place a next icon from a list of icons of the current population into the current screen.

Possible Layout Generator 429 further includes a Back-track Mechanism 431b connected from and interoperating with Search Forward Mechanism 431a which backtracks on each placement of each Graphic Icon 144 or other visual object of the current population in the current screen until all possibilities have been considered, wherein a backtrack is the removal of the most recently placed icon and an attempt to place a next icon from the list of icons of the current population into the screen and, if no subsequent icon can be placed after removal of the most recent icon, a removal of the next previously placed icon and an attempt to place a next icon from the list of icons of the current population.

A Layouts Storage Manager 432 then stores each Layout 422, that is, Plan 424, in a Layout Generation Memory 434, shown in FIG. 4A, for subsequent testing and selection. In this regard, a Layout Test Mechanism 436 is connected from Layout Generation Memory 434 through Layouts Storage Manager 432 to read each Layout 422 from Layout Generation Memory 434 and to test each new resulting Layout 422 against all other Layouts 420 previously generated in Step 430 and stored in Layout Generation Memory 434.

Layout Previous/New Selector 438 is connected from Layout Test Mechanism 436 and selects between a new Layout 422 and a previously existing Layout 422 according to a predetermined criteria. For example, and in the present embodiment, if a new Layout 422 has a subpopulation of a previous Layout 422, Layout Previous/New Selector 438 discards the new Layout 422. If a previous Layout 422 has a subpopulation of a new Layout 422, Layout Previous/New Selector 438 replaces the previous Layout 422, unless disqualified in a following step, as described below. If a previous Layout 422 has a subpopulation of the new Layout 422, Layout/Previous Selector 438 discards the new Layout 422 and, if a previously existing Layout 422 has the same population as a new Layout 422, Layout Test Mechanism 436 selects between the previous and new Layouts 420 by discarding one or the other by either (1) random selection between the previous and new Layouts 420 having the same population or (2) selecting the Layout 422 having the greater asymmetry as potentially generating the larger number of different Layouts 420 through a subsequent step of usage-phase modification, described below.

At this stage in the process there may still survive Layouts 420 having populations that are subpopulations of other surviving Layouts 420, such as a Layout 422 that eliminated a previously generated Layout 422, that is, a Layout 422 with a subpopulation of its own, that may in turn might also disqualify others Layouts 420 previously generated which also have subpopulations of that Layout 422's population. A final selection of Layouts 420 may therefore be performed by a Layouts Comparator 440 wherein the populations of each pair of surviving Layouts 420 are compared and Layouts 420 having populations that are subpopulations of Layouts 420 are discarded. Alternately, this process may be

performed by comparison of each pair of Layouts 420 in Layout Test Mechanism 436, depending upon which implementation proves most efficient in a given embodiment of Layout Generator 410.

Finally, the surviving Plans 422 encoding the final surviving Layouts 420 are tabulated and stored in are tabulated, as demonstrated in one or more Layout Tables 412. In this regard, it should be noted that in a presently preferred embodiment of the invention Plans 422 are grouped in Layout Tables 412 by screen size and aspect ratio, often with each Layout Table 412 continuing the Plans 422 for a given screen size and aspect ratio, and that Layout Tables 412 may then be indexed, first, by available display, or screen, size and aspect ratio, with the selected Layout Table 412 then being indexed by the icon population to read therefrom a Plan 424, if available therein. In other implementations, the Plans 422 may be grouped first by populations and then by screen size and aspect ratio.

It should be noted that in as much as it is often necessary to generate no more than one, two or three Layouts 420 for each maximal achievable population for a particular screen, Step 430 may be implemented alternatively by first searching for the full area occupancy populations for the screen for each possible maximal set of icons that would fill the screen area, with Layout Generator 410 searching for a fitting of each of the sets of icon shapes into the screen area. Then, for each population that cannot be realized, Layout Generator 310 searches for Layouts 420 for each possible subpopulation of that population that contains one less member, repeating the search with successive subpopulations that are each reduced a different icon type and, in each branch of the search, repeating the search with progressively reduced subpopulations until a subpopulation is found that can be fitted into the screen area, to find all possible subpopulations of the original population that can be fitted into the screen area. The resulting Layouts 420 are then culled by comparison to previously generated Layouts 420, as described above.

It will be recognized by those of skill in the relevant arts that the procedure of Steps 430 through 440 described above may require significant computing power to time to complete due to the large number of possible screen sizes and possible plans that must be searched for each possible population. The method of the present invention, however, and as described below, provides additional initial steps to increase the speed and efficiency of the generation of Plans 422.

As illustrated in FIG. 4E-2, therefore, and according to the present invention, mechanism described above with regard to FIG. 4E-1 may further include mechanism for performing the following operations in association with or preceding the operations performed in Possible Layout Generator 429 to generate patterns of various instances of icon layouts in various screens and to provide the resulting patterns for use the process described above.

In this regard, and referring to FIG. 4E-2, Layout Generator 410 may further include a Screen Map Generator 442 for generating, for each screen size and aspect ratio up to a maximum screen height (or width) of X units, a corresponding Screen Map 444 at a resolution, for example, of Y bits-per-unit-square in as many X bit words as the screen is wide (or high) wherein X is selected as a convenient word length for processing in the system in which Layout Generator 410 is implemented and Y is, for example, the smallest dimension, in bits, of any icon. For example, many computers operate efficiently with 16 bit words and, accordingly X is selected as 16 in a presently preferred embodiment of Layout Generator 410.

The Screen Maps 444 are then provided to an Instance Patterns Generator 446 that, for each icon type, that is, icon size and aspect ratio, generates as many screen-size "Instance" Patterns 448 as there are possible locations in the Screen Map 444 for that type of icon, using special encoding for clear space at top and bottom between the placement of a icon and a side or the top or bottom of the Screen Map 444 as necessary. This process of determining whether a given instance of an icon of a given type into the Screen Map 444 will fit, and placing or removing it, is thereby comprised of fast logical AND, OR and EXCLUSIVE-OR operations, respectively.

It will be noted that with regard to allowing clear space along any side of the Screen Map 444 that if there is no icon type under consideration with minimum dimension less than two, then it is unnecessary to consider instances, or placements of the icon in the Screen Map 444, having one-unit space between the icon and an edge, unless it is necessary due to the shapes of an icon and the screen, as in the placement of a 2x6 icon on a 7x7 screen. Therefore, in making instance patterns of icon positions, Step 446 omits near-but-not-on-side locations except where necessary.

The result of these operations is thereby at least one Instance Pattern 450, an example of which is illustrated in FIG. 4F, containing a sufficiently complete set of Locations 450 for each icon type in the screen represented by Screen Map 444, each Location 448 representing a possible instance of the icon type in the given screen. The example of an Instance Pattern 450 illustrated in FIG. 4F shows a sufficiently complete set of Locations 450 for 3x4 icons in a 7x9 screen wherein each Location 448, each of which is indicated by a *, identifies the location of the upper left corner of a 3x4 icon for a possible placement, or instance, of an icon of that type in the given screen.

Finally, a Location Instances Enumerator 452 enumerates the instances of the icon of the given type in the screen in order of proximity to the screen corners for each screen and icon type to be considered in a corresponding Instance Enumeration 454, and provide the Instance Enumerations 454 for use by Possible Layout Generator 429.

As has been discussed above, the process executed by Possible Layout Generator 429 involves a significant number of reiterations of icon placement steps and backtrack steps, which in turn entails the inadvertent rediscovery of members of sets of icons far down through the process steps that conflict with one another. As such, the processes and operations described above may be further enhanced for the case of large screens, such as 12x12 or larger, by a method wherein variously located instances of each shape of icon to be placed in a screen are sorted into disjoint sets according to their locations in the screen and each set is treated as a "supericon", the supericons then being used in the screen filling process described above.

As illustrated in FIG. 4E-3, Layout Generator 430 may thereby further include a Screen Spatial Division Generator 456 that determines, for a large screen such as 12x12 or larger, the various possible location instances of each type of icon with respect to nine spatial divisions of the screen, which are illustrated in FIG. 4G for a 12x12 screen. As may be seen therein, the screen is divided into four quadrants by horizontal and vertical axes of symmetry and four of the spatial divisions are formed by the four corner quadrants formed by the two axes of symmetry while the right and left halves of and along the horizontal axis of symmetry, the upper and lower halves of and along the vertical axis of symmetry and the intersection point of the axes of symmetry in the center of the screen form the remaining five spatial

divisions. The nine sets correspond to Spatial Divisions 458a, 458b, 458c and 458d, which correspond to the four corner quadrants, Spatial Divisions 458e, 458f, 458g and 458h, which correspond to the halves of the two axes, and Spatial Division 458i, which corresponds to the intersection point of the two axes.

Thereafter, a Location Instances Sorter 460 sorts, for and according to each type of icon, the location instances of the icon in the screen according to their positions with regard to nine spatial divisions of the screen.

Then, and for each of the nine sets, a Location Instance Search and Compose Mechanism 462 searches for and composes compatible, that is, non-overlapping, combinations of icon location instances, for example, by operation of Layout Generator 410 or by presenting possible choices to a human operator, and a following Super-object Generator 466 designates each compatible combination as a Supericon 464, with the purpose of filling the screen as completely as possible with Supericons 464.

For each of the nine sets of icons, and in principle, all combinations of 0, 1, 2, or 3 or more icons may be considered as Supericons 464. The search for such combinations may be restricted, and the search accordingly shortened, according to certain principles.

First, for Spatial Divisions, or sets, 458a, 458b, 458c and 458d, which occupy the four corner quadrants of the screen, all combinations having at least one quadrant with zero members may be discarded as no maximal population can result from a combination having an empty corner quadrant. Further, in any pattern in which a corner unit of a quadrant is not occupied, one of the icons near the corner may be moved, or translated horizontally or vertically, into the empty corner quadrant, and that pattern will result at least one other point in the search. That is, the two instances, with the icon near the corner and with the icon in the corner, are essentially equivalent so that the icon may as well be placed in the corner rather than considering the two instances separately.

Second, there will most probably be one or more combinations wherein there are "slits" one unit wide between two icons which cannot be filled by vertical or horizontal translation of one of the icons, and which may in fact impede the placement of other icons. Also, the configuration that would result from moving the icons to close the "slits" will most probably occur elsewhere in the search and, as a result, as no maximal population can result from a combination generated by vertical or horizontal translation of an icon to eliminate a "slit" space between two icons. Such combinations are therefore preferably discarded from consideration.

It will be noted that the above two situations are instances wherein there are two equivalent combinations, one where there is a non-fillable slit and one where an icon has been moved to fill the slit and results in an equivalent non-fillable slit. In these instances it is not necessary to consider both of the equivalent combinations, but only those combinations wherein moving an icon results in the locking out of an icon placement possibility. For example, and referring to FIG. 4H, if the 4x3 icon at the upper left were one unit further right, no new combinations or placements would result than what is possible with the icon in its present placement, so it is not necessary to consider the combination with the icon moved one unit to the right. In the instance wherein the upper left 6x2 icon and the 4x3 icon are reversed, however, with a unit space between the icons, a movement of the 6x2 icon to the left precludes a 3x4 icon immediately under the 4x3 from being placed, so that this instance should be considered.

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Finally, some combinations occupy exactly the same areas and have exactly the same subpopulations as other combinations and are therefore equivalent and may be discarded from consideration.

The search for such combinations may be restricted and the culling of combinations according to the above principles may be implemented as by Supericon Designator 466 operating in association with Location Instance Search and Compose Mechanism 448, or may be performed manually by presenting possible combinations to a human operator for decision. It should be noted that experimentation has shown that the application of these principles will result in approximately $\frac{3}{4}$ of the possible combinations surviving the culling process, so that the generation and search process can accordingly be reduced to approximately $\frac{3}{4}$ to the ninth power of the original time required, that is, to approximately less than a tenth of the original time required to generate and search layouts for large screens.

Lastly with regard to the use of Supericons 464 to reduce the number of reiterations of icon placement steps and backtrack steps, it will be apparent from the above discussions that certain sets of combinations generated as described above will result in sets of combinations that are rotational or reflectional equivalents to one another. For example, each of several starting points of a search for combinations may start with a set of combinations with one combination from each of the corner quadrants of the screen, that is, a 458a, 458b, 458c and 458d combination wherein each of the combinations, when appropriately rotated or reflected, is equivalent to the other combinations. This may be illustrated as in FIGS. 4H and 4I wherein it is apparent that the two starting sets of combinations are equivalent because the subpopulation and covered area pattern of FIG. 4I is the same as that of FIG. 4H when subjected to a rotation about the right half horizontal axis.

As also discussed above, it is anticipated that the final usage of Layouts 420 to generate screen displays anticipates that at least certain Layouts 420 will be rotated or reflected to generate yet other Layouts 420, so that the end result of the entire process could be the generation of equivalent Layouts 420.

As a consequence, the search for such combinations may further be restricted and the generation of combinations enhanced by a process wherein the starting combinations are pruned, or culled, or any set of starting quadruple combinations that are rotational or reflective duplicates of already generated starting combination quadruples.

The speed and efficiency of Possible Layout Generator 429 and thus of the subsequent processes described above may also be increased by further mechanism associated with Possible Layout Generator 429 or a subsequent process wherein a large screen is generated as a combination of two or more smaller screens.

Therefore, and as illustrated in FIG. 4E-4, Layout Generator 410 may further include a Corner Area Examiner 470 connected from and to Possible Layout Generator 429 which, for very large screens, examines the corner areas of each Layout 422 as it is generated and retain only Layouts 420 whose corners are filled in unique ways, that is, discard one or any pair of Layouts 420 if the patterns of similar icons filling their corners are rotational or reflectional equivalents, that is, if one is a 5, 7, or B reorientation of the other. Corner Area Examiner 470 may also apply the criteria that all four corners of a Layout 422 be occupied.

Finally, the speed and efficiency of Layouts Generator 430 and thus of the subsequent processes described above may also be increased by additional processes primarily intended

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for use with large screens, for example, greater than 12×12 . In these additional processes, Layouts 420 are composed by dividing the screen into two or more smaller screens, generating solutions for the smaller screens, and generating the solution for the original large screen by combining the solutions for the smaller screens. In this embodiment, as illustrated in FIG. 4E-5 and primarily for use with large screens, Layout Generator 410 will further include a Screen Sub-Area Divider 472 connected from Possible Layout Generator 429 which divides each screen, such as a 13×12 screen, into two or more smaller screens or sub-areas, for example, $(n) \times 12$ and $(13-n) \times 12$ wherein $n=5, 6, 7$. Screen Sub-Area Divider 472 then provides the smaller sub-area screens to Possible Layout Generator 429, which uses each sub-area screen independently as a display area for the generation of corresponding Layouts 420.

Then, a Screen Sub-Area Combiner 474 operates in conjunction with Layouts Comparator 440 to compose Layouts 420 for the original full size screen by joining the Layouts 420 generated for the smaller sub-area screens, adding the populations of the smaller screens, transposing the coordinates of the smaller screens into coordinates of the large, combined screen and test for duplication and inclusion relationships among the resulting Layouts 420, as described previously.

Alternatively, the Layouts 420 may be generated for the smaller screens as described above and a Layout 422 may be generated for the original larger screen by Location Instance Search and Compose Mechanism 462 wherein Layout Generator 410 or another program searches Layout Tables 412 for a combination of smaller screens that may be combined into a screen having the dimensions and population of the large screen, and so combines the smaller screen Layouts 420 into a Layout 422 for the large screen.

The above described process of generating a layout for a large screen as a combination of layouts for smaller screens may be illustrated with the aid of FIG. 4J wherein an $M \times N$ Screen 476 is divided into two SubScreens 476A and 476B having dimensions, respectively, of $M \times A$ and $M \times B$ and which may be side by side, as illustrated in FIG. 4J, or one above the other. Layouts 420 for SubScreens 476A and 476B that are useful in generating a Layout 422 for Screen 476 may be generated and tabulated in advance by considering the generating all pairs of sublayouts for screens having dimensions of $M \times A$ and $M \times B$ wherein $A+B=N$. Layout Generator 410 can generate a very large number of populations that can be arranged in $M \times N$ screens by adding various $A+B$ populations. As described above, Layout Generator 410 may discard any resulting population that is a subpopulation or equivalent population to one already generated, and may disqualify those layouts whose populations are subpopulations of a new layout.

It will be apparent from the above discussions that the method of constructing Layouts 420 for screens as combinations of Layouts 420 for smaller screens that can be combined into the larger screen can be extended to combinations of greater numbers of smaller screens, as illustrated in FIGS. 4K, 4L and 4M, which respectively illustrate a Layout 422 for a 7×7 screen as a combination of Layouts 420 for four 4×3 and 3×4 screens, a Layout 422 for a 14×14 screen as a combination of Layouts 420 for 16 4×3 and 3×4 screens, and a 14×14 screen as a different combination of Layouts 420 for 16 4×3 and 3×4 screens. It is also shown in FIGS. 4K, 4L and 4M that the resulting screen need not have "faults" or lines of rotational or reflective symmetry among the smaller screens comprising the larger screen.

Finally in this respect, the Plans 422 for composite layouts for larger screens comprised of two or more smaller screens

may be tabulated into Layout Tables 412 by listing the Plans 422 by its subparts, either by assigned serial numbers or by populations, rather than by the member icons, and that the definitions of the composite Plans 422 can cascade.

Also, the previously discussed methods for generating additional Layouts 420 from a Plan 424 stored in a Layout Table 412 by rotation or reflection of the stored Plan 424, that is, its corresponding Layout 422, may be used to generate additional composite Layouts 420 by rotation or reflection of the stored composite Plan 424.

e. Using Plans 422

As discussed above, a user of a Visual Links Organizer 166, and in particular Display Generator 141 and one or more Layout Tables 412, will generate requirements such as "for a 12x10 screen, provide a plan for placing population 3321." Such a need is satisfied (or not) by a linear scan of the appropriate Layout Table 412 for the first Plan 424 that contains at least the desired population. The result of the search is either a Plan 424 or a failure, the latter meaning that the stated population of icons cannot be arranged on specified screen, although it should be noted that if the specified screen is inverted with respect to screen for which a Plan 424 exists, the request may be satisfied by inverting the Plan 424 for the screen for which a Plan 424 is found.

As described above, a Plan 424 is a specific geometric layout for the stated numbers of icons of the specified types and for the specified screen and the user may use the Plan 424 unaltered or, for the sake of variety in the appearances of numerous similar layouts, may perform various alterations to the Plan 424 to vary the visual appearance of the Plan 424.

For example, criteria for the search for a Plan 424 is satisfied if the search population is a subpopulation of an existing Plan 424. Therefore, and if the user does not have additional icons of the number and types necessary to fill the available space in the Layout 422 represented by the Plan 424, there is at least some flexibility as to which of the icon positions to use and which to leave blank, thereby varying the visual appearance of the Layout 422. The choice of which icons positions to fill may be made, for example, at the individual discretion of the user, for example, using "drag and drop" or "point and click" operations to associate icons with locations, or the locations may be assigned by means of a random number generator, perhaps, in the instance of reuse of the same Layout 422, using the assignments for an earlier use of the Layout 422 as a seed for the later uses of the Layout 422.

In further example, the visual appearance of a Layout 422 may be varied by rotating or reflecting the Layout 422 about, for example, the vertical or horizontal axis or the 1, 5, 7, B orientations of the Plan 424, either at random or by user selection. Also, if the specified screen is square and the population is of the form a b b a, the Layout 422 may be reoriented about the 2, 4, 8, and A axes, with reinterpretations of the icon types, such as 6-high<-->2-high and 4-high<-->3-high.

In a like manner, if the Layout 422 contains a vertical or horizontal fault, the placement of the subrectangles defined by the fault may be exchanged or, if there exists a subrectangle in Layout 422, the area of the subrectangle may be reoriented by along the 5, 7, or B axes or, if there is a subsquare and its subpopulation is of the form a b b a, then the icons of the subpopulation of the subsquare may be reoriented in a similar manner.

Finally, if there is empty space along any side of an icon, the icon may be moved vertically or horizontally to occupy the empty space.

It will be appreciated by those of ordinary skill in the relevant arts that these processes are easily programmed so as to happen automatically, and require little time to execute. It will also be apparent that it is useful to perform these operations in various orders and iteratively in various combinations, so long as new geometric layouts result.

5. Description of Visual Links 142 (FIGS. 5A-5G)

As previously discussed, for example, with reference to FIG. 1B, a Visual Link 142 may generally include a Universal Resource Locator (URL) 128, a Title 130, a Text 132, and a Date 134, and may include Keywords 136, and will include a Graphic Icon 144. As has been described in detail above, a Graphic Icon 144 is generated or extracted from the graphics and text information present in the corresponding HTML document and which serves as a visual representation to the user of the associated document or file. The role of Graphic Icons 144 may also be fulfilled by graphic representations of various forms of files, locations or recipients on a network, such as photographs of electronic mail recipients.

In addition to representing a document, file, location or recipient, for example, in a visual index of documents, files, locations or recipient, a Graphic Icon 144 is a computer programming construct which permits a small bitmapped picture, that is, a Graphic Icon 144, to serve as an active button on the screen of a World Wide Web browser, electronic mail program or other application program. A user may then initiate access to the document, file, location or recipient for a corresponding purpose by "clicking" on the button. As has been described, Graphic Icons 144 enable users to more readily and easily recognize and remember a Web site, document, file, location or recipient, by providing a representative visual representation of the Web site, document, file, location or recipient, than do text indicators or, for example, ASCII string universal resource locators (URLs).

As illustrated in FIG. 5A, a Visual Link 142 concatenates, combines, or otherwise associates, a normally encoded bitmapped picture, that is, a Graphic Icon 144, with a set of Visual Link 142 data, referred to hereafter as a Visual Link Dataset 500, and includes a means for associating the Graphic Icon 144 and the Visual Link Dataset 500. The following will describe each of these elements in turn.

As has been described, the active button bitmapped picture is comprised of a Graphic Icon 144, which is, for example, on the order of 100 by 100 pixels in size and is intended to be encoded in any of the commonly known means of bitmap encoding, which include, but are not limited to, JPEG, GIF and Microsoft BMP. The image data may be compressed by any of the methods thereby supported in each case and, as used for the purposes and uses of Visual Link 142, the basic structure and detailed content of the picture file remains unaltered.

A Visual Link Dataset 500, in turn, is an ASCII file or the equivalent, such as an encrypted alphanumeric file, which contains, most essentially, a URL 128 which, in turn, is an ASCII character string, for example,

<http://www.netwavelink.com/pointreview.HTML>. A minimum Graphic Icon 144 dataset for this example might therefore appear as illustrated in FIG. 5B wherein it is shown that this minimal Visual Link Dataset 500 includes three Designators 502, respectively indicated as Graphic Icon 144=, URL 128=, <http://www.netwavelink.com/pointreview.HTML>, and END 504=

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Each Designator 502 is a body or item of data related to the Visual Link Dataset 500 and indicates the nature of the following ASCII data, if any, and ends with the '=' character. 'URL 128' of the corresponding Designator 502 illustrated in FIG. 5B thereby represents the URL 128 of a correspond-

ing document, site, file, location or recipient or the like, with the "=" indicating the end of the designator. While the URL 128 Designator 502 is the crucial item for contacting a web site, the user will often find it helpful if additional relevant information is stored in the Visual Link Dataset 500, thus making information available immediately when and if the Graphic Icon 144 is stored locally. A typical Visual Link Dataset 500 with such additional information may appear as represented in FIG. 5C wherein the Visual Link Dataset 500 is illustrated as including the Designators 500 represented as Graphic Icon 144=, URL 128=, Text 132 including a Subject 506= and an Author 508=, KeyWords 136= and an END 504=. It should be noted that only Graphic Icon 144=, URL 128= and END 504= are essential and that only URL 128= absolutely requires an argument, that is, the ASCII character string or equivalent comprising the URL 128.

A further example of a rather extensive Visual Link Dataset 500 might be:

Graphic Icon 144=Version 1.0
 KeyWords 136=web browser interface icon button visual internet
 bitmap compression thumbnail
 Subject 504=web_browsing
 Category=browsers
 Company=Netwave, Inc.
 USPS=440 Middlesex Road
 Tyngsboro MA 01879
 Phone=(603) 649-8633
 FAX=(603) 649-8699
 E-Mail=gmiliefsky@netwave.com
 Description=Provider of "Visual Links Objects" for making cyberspace easier.
 Comment=
 PrevGraphic Icon 144=
 URL=http://www.netwavelink.com/pointreview.HTML
 SerialNo=0000000045
 SeeAlso=http://www.foobar.edu/santa.clause
 SeeAlso=http://www.patriot.mil/big.guns
 Author=Gary Miliefsky
 Created=11/10/96
 LastMod=11/14/96
 END 504=

NOTE: This dataset (11/14/96), is intended only for the purpose of debugging the various software modules that Netwave will soon export. IT IS NOT TO BE DISTRIBUTED TO OUTSIDE PARTIES EXCEPT AS AN EXAMPLE, AND THEN ONLY TO THOSE WHO HAVE SIGNED A NON-DISCLOSURE AGREEMENT. Although this dataset was current as of Nov. 17, 1996, there may be yet newer versions, with slightly different names. Look for all files with names samp*.*.

It will be noted that this example includes text appended at the end, which may be helpful for developers or other users, and that the END 504= Designator 502 is the end of data of significance to the Graphic Icon 144 parser and hence to all computer programs that interrogate or otherwise use Graphic Icons 144.

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It should also be noted that in the present implementation, Designators 502 are case-insensitive, meaning that any upper case letters and their corresponding lower case versions are interchangeable. In addition, there may be alternative forms for at least some Designators 502. For example, in order to save storage space and transmission time, at least some Designators 502 may be represented by four-character abbreviations, such as KEY= for KeyWords=. In other examples, the following Designators 502 may be represented by the corresponding following abbreviations:

Graphic Icon 144= by Icon 144=;
 Comment= by COM=;
 Remark= by REM=;
 Date= by DAT=;
 Author= by AUT=;
 Contact= by CON=;
 Key Words= by KEY=; and,
 Subject= by SUB=.

The above illustrated group or set of Designators 502 is intended to be a growing set, with additional Designators 502 added as found necessary or advantageous for general use. It may, for example, be desirable to add a "rating system" designator whose arguments indicate the depiction or or reference to sex, nudity, violence or language unsuitable for younger age audiences. There may also be designators whose arguments hold information dealing with encryption or permissions, whereby certain parts of the dataset may be read or interpretable only by users possessing appropriately entitling decryption methods or passwords. For example, the site referenced by a URL may thus be visible or accessible only to privileged users.

It is also intended that specific users may add Designators 502 to meet their specific needs, such as failed= for the cumulative count of failures of the site to respond, found= for the count of successes at downloading from the site, and FSLS= for the count of failures since the last successful access to the site.

It is intended that Visual Link Datasets 500 may be parsed, interpreted and use by relevant systems and programs from a variety of sources. As such, it is further intended that Visual Link Datasets 500 conform to a commonly accepted set of at least minimum rules and definitions so that any given Visual Link Dataset 500 may be used, at least to the minimum necessary extent to meet the intended purpose, by any system or program conforming to these rules and definitions. The following explicit rules and definitions, or an alternative but generally similar set of rules and definitions, are exemplary of such a set of rules and definitions.

Accordingly, the following are definitions used in a presently preferred implementation of Visual Link Datasets 500:

A WHITESPACE is a contiguous string of non-printing non-ink characters, most notably space, tab, carriage return, line feed, and the implicitly understood beginning-of-file and end-of-file.

A TOKEN is a contiguous string of visibly-printed ASCII characters that appear between successive whitespaces.

A DESIGNATOR 502 is a token that ends with the character '='.

An ARGUMENT is a token not ending with '=' appearing somewhere between successive designators.

An ENTRY is logically a line of Visual Link Dataset 500 code consisting of a Designator 502 and the following argument(s), if any, up to but not including the next designator. According to a present implementation of Visual Link Datasets 500, the arguments of a designator need not appear

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on one line, that is, the whitespace separating arguments may be or include carriage return and/or linefeed.

In a like manner, the rules and practices for a presently preferred embodiment of the present invention include that a Visual Link Dataset 500 is comprised of:

- a Graphic Icon 144= <argument(s)>;
- <entry or entries other than the URL 128=>;
- a URL 128= plus one argument in the form of a URL-format web address;
- <entry or entries other than the URL 128=>;
- END 504=; and,

<text that will be ignored by all programs, wherein the items delineated in < > above are regarded as optional.

In addition, it is presently good practice is to avoid arguments that end in '=', and when this is impossible, then to end the argument with '=' written in the form '^=' , correspondingly writing the character '^' in the form '^'^'.

In other usages, the minimal Visual Link Dataset 500, like that depicted above, may absolutely require some designator and related arguments other than a URL=, such as an e-mail address, or phone number or postal address.

According to the presently preferred embodiment, the order, number of entries, and their content in a Visual Link Dataset 500 is arbitrary except that

- (1) there must be one and only one Graphic Icon 144=, URL 128=and END 504=,
- (2) the very first token of a Visual Link Dataset 500 must be Graphic Icon 144=, except that this token is not required in the Visual Link Dataset 500 version wherein the Graphic Icon 144 and the Visual Link Dataset 500 are contained in a single file as the dataset need not point to the icon,
- (3) the first and probably only argument of the URL 128= token must be, or at least thought to be, a bona fide URL 128, and
- (4) the END 504= entry is the last entry or token of the file that will be recognized and treated by support programs that parse or use Visual Links 142.

Also, and for purposes of human creation, examination and/or editing, it is preferable that a Visual Link Dataset 500 be comprised of human readable characters, such as ASCII printing characters, blank, carriage return and line feed.

As has been described herein, a Visual Link Dataset 500 may be generated automatically by a capture engine, such as a Visual Link Capture Engine 138, whereby Web sites are interrogated and the Graphic Icon 144 bitmap picture selected and other data gleaned by downloading and scanning the HTML file from each site. Since a Visual Link Dataset 500 is encoded as an ASCII file, however, a Visual Link Dataset 500 may alternatively be generated manually, for example, by a person using a text editor such as a normal word-processing program.

Having considered Graphic Icons 144 and Visual Link Datasets 500 herein above, the following will consider the means for association of a Graphic Icon 144 and a Visual Link Dataset 500 to construct a Visual Link 142. Association of Picture and Graphic Icon 144 Dataset.

As discussed, a Visual Link 142 consists essentially of a picture, that is, a Graphic Icon 144, and a Visual Link Dataset 500, which must be associated with one another to form an entity referred to herein as a Visual Link 142. and a Graphic Icon 144 dataset This may be accomplished in several ways, as illustrated in FIGS. 5D through 5G., the presently preferred method being illustrated in FIG. FIG. 5F.

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Referring first to FIG. 5D, in this embodiment the Graphic Icon 144 picture is described in a typical graphic or image file format, such as JPEG or GIF, with pixel data compressed or not, and is this file is completely isolated from the Visual Link Dataset 500, forming a separate file, and is unaltered. The association between the Graphic Icon 144 file and the Visual Link Dataset 500 file is maintained on a higher level, for example, in a database or link file structure, identified in FIG. 5D as Link 510 that contains at least the relative or absolute Pathnames 512A and 512B of the two files, or the equivalent.

Advantages of this embodiment is that the picture file may be used in any and all of the possible ways that are relevant to the format of the encoded bitmap picture, as can be the Visual Link Dataset 500 file, and the Graphic Icon 144 picture file and the Visual Link Dataset 500 file are individually created or modified more easily. A disadvantage of this embodiment, however, is that three items, the Graphic Icon 144 file, the Visual Link Dataset 500 file and the database or file structure relating the two, must be maintained in agreement, and that more care and/or utilities are thereby needed to maintain between the components of the Visual Link 142.

An alternate embodiment is illustrated in FIG. 5E wherein it is shown that the Graphic Icon 144 picture file and the Visual Link Dataset 500 file are again separate files but that the association between them is indicated in a Designator 502 in the Visual Link Dataset 500, such as 'PIC 514='. In this embodiment, the argument of PIC 514= is the absolute or relative pathname, or equivalent for the Graphic Icon 144 picture file, thereby eliminating the database of file structure used in the embodiment of FIG. 5D to relate the Graphic Icon 144 and the Visual Link Dataset 500. The advantages of the embodiment illustrated in FIG. 5E are the same as for the embodiment illustrated in FIG. 5D, and the disadvantages are similar in that there are still two files whose locations and/or contents must be maintained consistently, although the disadvantages are reduced with respect to the embodiment of FIG. 5D.

Yet another embodiment, and in this instance the presently preferred embodiment, is illustrated in FIG. 5F. As illustrated therein, the Visual Link Dataset 500 is appended to an otherwise unaltered Graphic Icon 144 picture to form a single File 516, which may typically be an image file, wherein a Length-of-Dataset Number 518A is appended to the Visual Link Dataset 500 in the single File 516 and represents the location of the beginning of the Visual Link Dataset 500 in the File 516 relative to the end of the File 516, and thereby the end of the Graphic Icon 144 picture in the File 516 relative to the end of the File 516. The beginning of the Visual Link Dataset 500 is thereby found by seeking to end-of-file minus size of Length-of-Dataset Number 518A, interpreting the Length-of-Dataset Number 518A found at that location, and seeking backward this number of bytes to find the beginning of the Visual Link Dataset 500 component, and the end of the Graphic Icon 144 picture component.

In the present embodiment, Length-of-Dataset Number 518A is stored as a fixed number of ASCII characters, such as four, and high digit first, rather than as an n-byte number, thereby avoiding possible confusion that could arise from differences in byte order of words and double words, and differences in bit order in a byte, in different systems. In yet other implementations of the embodiment shown in FIG. 5F, Length-of-Dataset Number 518A may be accompanied by a URL Pointer 518B identifying the location of the URL 128 Designator 502 in the file and an END Pointer 518C identifying the location of the END 504= Designator 502 in the file.

It will be apparent that the advantages of this embodiment are that there is only one file to maintain, move or copy and that the entire file can be used for most purposes relevant to the display of a non-augmented picture file, such as a display on a screen. It should be noted, however, that if Graphic Icons 144 are dealt with only by programs designed specifically for this purpose, this problem should not arise.

Possible disadvantages could arise in this embodiment due to the structure of the file wherein the actual length of the composite file is different from the length of the file as may be declared within the image file subpart as the user or program constructing this part has generally not anticipated an appendment. That is, the declared length of the composite file would typically be based upon the size of one component of the file, such as the Graphic Icon 144 component of the file if the composite file is treated as a normal picture file. If it is operated upon by a utility that operates upon the file based upon the declared and expected end-of-file length, the utility may read and operate upon the expected rather than actual length of the file. As a consequence, portions of the file, such as the Visual Link Dataset 500 component, may not be operated upon and may, for example, be truncated in a copy or move operation. The same problem may arise when a person or program copies the file into a buffer that accommodates only the self-declared size of the picture file as declared in the image part of the file.

In a related potential problem, any editor that is selected for use in modifying the file must be chosen so as to not make end of line or file modifications or other conversions that might alter the data stored in, for example, the Graphic Icon 144 picture component. In this instance, it may be preferable that the Visual Link Dataset 500 component of the composite file be split off from the composite for editing, and the two files subsequently re-concatenated.

It will be noted, however, that a system's file system will generally know or recognize the actual complete size or length of the file and it is only the length indicator or indicators within the image part of the file that may give misleading indications of the length of the composite file. Programs or utilities that do not rely only on the self declared length of the image part of the file will therefore generally avoid such problems.

In a fourth alternate embodiment, many bitmap picture file protocols, such as those for JPEG and GIF, accommodate application specific extensions or inclusions and, in these instance, the Visual Link Dataset 500 could be added to the Graphic Icon 144 image file as an application specific extension. This embodiment is advantageous in corresponding to established standards of the field of art and in relaxing or avoiding at least some of the caveats discussed above in appending a Visual Link Dataset 500 component to an image file. A disadvantage, however, is that utility programs for dealing with the Visual Link Dataset 500 components of the resulting composite files must be custom-designed or adjusted to each such image file format.

Finally, those of skill in the relevant arts will appreciate that there are still further methods for associating the two files. For example, a common basenname with different extensions, such as 'elephant.gif' and 'elephant.txt', would have essentially the advantages and disadvantages discussed above with regard to the embodiment illustrated in FIG. 5E.

7. Hash Protection of Files Such as Visual Links 142 (FIGS. 6A and 6B)

Referring to FIG. 6A, therein is represented a Hashing Protection Mechanism 600 implemented, for example, in a Local System 112 or a Server System 114 for encoding

computer system files, such as a Visual Link 142 file, to allow detection of the unauthorized construction or modification of such files.

Hashing Protection Mechanism 600 performs this function for a File 602 by reading a Encrypting Part 604 of the Data 606 of the File 602, wherein Encrypting Part 604 comprises at least a part of Data 606, and generating a "Hash" Encrypted Value 608 by performing a known hashing operation on Encrypting Part 604. Hashing Protection Mechanism 600 then associates the Hash Encrypted Value 608 with the File 602, for example, by embedding Hash Encrypted Value 608 as a Stored Hash Encrypted Value 608S in a Storing Part 610 of Data 606 that is not included or contained within Encrypting Part 604. For these purposes, and as illustrated in FIG. 6A, Hashing Protection Mechanism 600 includes a File Reader 612 for identifying and reading an Encrypting Part 604 of a File 602, a Hashing Mechanism 614 for performing the hashing operation on the Encrypting Part 604, and a File Writer 616 for writing Stored Hash Encrypted Value 608S into Storing Part 610.

Thereafter, Hashing Protection Mechanism 600 may determine whether there has been an unauthorized construction or modification of a File 602 has been altered by reading Encrypting Part 604, performing the hashing operation on Encrypting Part 604 to determine a Confirmation Hash Encrypted Value 608C, and comparing the Confirmation Hash Encrypted Value 608C with the Stored Hash Encrypted Value 608S from Storing Part 610. For these purposes, and as illustrated in FIG. 6A, Hashing Protection Mechanism 600 again includes File Reader 612 for reading Encrypting Part 604 and Hashing Mechanism 614 for generating a Confirmation Hash Encrypted Value 608C from Encrypting Part 604. Hashing Protection Mechanism 600 further includes Comparator 618 for reading the Stored Hash Encrypted Value 608S from Storing Part 610 comparing the Stored Hash Encrypted Value 608S and the Confirmation Hash Encrypted Value 608C to determine whether the File 602 has been properly constructed or modified by an authorized user or system.

It will be apparent that, because the specific hashing algorithm used in the hashing operation is known or available only to users or systems authorized to construct or modify Files 602, only an authorized user or system will be able to generate a Confirmation Hash Encrypted Value 608C from Encrypting Part 604 that is equal to the Stored Hash Encrypted Value 608S. If the values are equal, then the File 602 has not been constructed or modified without proper authorization and, if the values are not equal then the File 602 has been constructed or modified with a hashing algorithm different from that available and known to the authorized users or systems. This method assumes, of course, that the hashing algorithm is held in secrecy, which is a common requirement for almost all protection mechanisms, and that the algorithm is sufficiently complex to avoid accidental or easy discovery, which is a general requirement of all protection mechanisms and a common characteristic of many hashing algorithms.

According to the present invention, Storing Part 610 in which Stored Hash Encrypted Value 608C is stored is comprised of portions of Data 606 that are not only separate from Encrypting Part 604 but also are characterized by having alternate forms of expression, that is, different states, that are semantically equivalent to a user or a computer system, and wherein the alternate, semantically equivalent states of the Data 606 in Storing Part 610 are used to encode the Stored Hash Encrypted Value 608C.

For example, there may be portions of Data 606 comprised of legible words or pseudo-words or abbreviations in

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English text that, for their primary purpose are semantically equivalent to a human user, such as "END" and "end", or that are treated in a case insensitive manner by a system. Assuming, for example, that a Stored Hash Encrypted Value 608C is comprised of or expressed as a binary string, such as "101", and that an upper case letter is used to indicate a "1" while a lower case letter is used to represent a "0", this Stored Hash Encrypted Value 608C could be encoded in the word "end" as "EnD" so long as this expression of "end" was, as necessary for its primary purpose, semantically equivalent to a user or that a system treated the word in a case insensitive manner. Thus, "end", "End", "cNd", "eNd", "END", "EnD", "eND", and "END" could all be used to encode different Stored Hash Encrypted Values 608C if these variants of "end" had equivalent meanings to a user or a system, as necessary for the primary purpose of the word.

Therefore, minute differences in ASCII code, for example, may signify bits of a Stored Hash Encrypted Value 608C, with one bit of the Stored Hash Encrypted Value 608C being represented by each ASCII character or string of identically treated ASCII characters, so long as the use of alternate versions of the characters or strings of characters did not interfere with the primary functions of the characters. Also, and as described above, these characters or strings of characters may not or should not be used as the Encrypting Part 604. In addition, the parts of a file that are used for Encrypting Part 604 and for Storing Part 610 should be easily identifiable and locatable by a system.

This method of the present invention for encoding a hash encrypted value generated from portions of the data of a file and stored in other portions of the data of the file having alternate but semantically equivalent expressions that may be used to encode the hash encrypted value is illustrated in FIGS. 6B-1 and 6B-2 wherein FIG. 6B-1 represents an original file and FIG. 6B-2 represents the same file with the bits of the hash encrypted value, which are listed in a column at the left of the file, encoded in the corresponding case-distinguishing bits of the ASCII characters used to encode the hash encrypted value. It will be noted that the substrings of characters that are considered as valid for encoding by alternate expression are all contiguous substrings of letters terminated by the "=" sign. It will also be noted that, for cosmetic reasons, in each such substring all characters but the first share the same change, that is, the same alternate form of expression and collectively represent one bit of the hash encrypted value, and that the beginning character of each substring is left in the upper case state.

It may be apparent, therefore, that the hashing protection method and mechanism of the present invention is no more complex and requires no more effort, for example, in maintaining the secrecy of the hashing algorithm, than alternate protection mechanisms. It is further apparent that the hashing protection method and mechanism of the present invention is advantageous in that the encrypted hash value is stored in a non-intrusive manner that takes no extra space in a file and does not change the encrypted hash value of the file and in a manner that does not impede human or system interpretation of the data in the file.

Finally, while the invention has been particularly shown and described with reference to preferred embodiments of the apparatus and methods thereof, it will be also understood by those of ordinary skill in the art that various changes, variations and modifications in form, details and implementation may be made therein without departing from the spirit and scope of the invention as defined by the appended claims. Therefore, it is the object of the appended claims to cover all such variation and modifications of the invention as come within the true spirit and scope of the invention.

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What is claimed is:

1. For use in a data processing system including a memory for storing programs and files containing data and a processor for operating on the data under control of the programs, a capture engine for extracting graphics information from a data file and generating a corresponding graphic icon forming a displayable image representing the graphics information, comprising:

a grayscale image generator for receiving an original image and generating a corresponding grayscale image containing brightness values representing the original image,

an edge image mechanism for receiving the grayscale image and generating a corresponding edge image representing areas of visually significant graphic structure in the grayscale image as represented by areas of change in the brightness values,

a candidate region search mechanism for receiving the edge image and identifying initial candidate regions of the edge image representing visually significant areas of the original image, and

a candidate region adjustment and comparator mechanism for selecting a candidate region to be used in generating a corresponding graphic icon and for adjusting the selected candidate region to conform to predetermined dimensions for a graphic icon.

2. The capture engine of claim 1, wherein the grayscale image generator comprises:

a grayscale lookup table for storing grayscale brightness values corresponding to each of the possible brightness values of image elements in original images,

a grayscale converter for reading the brightness values of the image elements of the original image, reading the corresponding grayscale brightness values stored in the grayscale lookup table, and generating a corresponding grayscale image wherein each image element of the original image is represented by a grayscale image element having the grayscale brightness value corresponding to the brightness value of the image element.

3. The capture engine of claim 2, wherein each image element of the original image is represented by a set of color values, the set of color values of an image element of the original element representing the color and brightness value of the image element, and wherein:

the grayscale lookup table contains a grayscale brightness value corresponding to each of the possible sets of color values of image elements in original images, and

the grayscale converter is responsive to the set of color values of each image element of the original image for reading the corresponding grayscale brightness values stored in the grayscale lookup table, and generating a corresponding grayscale image wherein each image element of the original image is represented by a grayscale image element having the grayscale brightness value corresponding to the set of color values of the image element.

4. The capture engine of claim 2, wherein:

the grayscale image generator generates each image element of the grayscale image from a plurality of corresponding elements of the original image so that the number of image elements in the grayscale image is proportionally reduced from the number of image elements in the corresponding original image.

5. The capture engine of claim 1, wherein the edge image mechanism comprises:

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an edge image generator for receiving an input grayscale image and generating a corresponding output edge image wherein each image element of an output edge image is represented by an edge value proportionate to the difference between the brightness value of the corresponding image element in the input grayscale image and the brightness values of the neighboring image elements of the corresponding image element in the input grayscale image, wherein an output edge image thereby represents areas of visually significant graphic structure in the input grayscale image as represented by areas of change in the brightness values of the input grayscale image.

6. The capture engine of claim 5, wherein the edge image mechanism further comprises:

a lowpass filter connected between the grayscale image generator and the edge image generator for receiving a grayscale image and generating a corresponding filtered grayscale image of reduced resolution and provides the filtered grayscale image to the edge image generator as the correspond input grayscale image to the edge image generator, wherein each image element of a filtered grayscale image is determined as a proportioned summation of the brightness values of selected neighboring image elements of the image element of the grayscale image, so that a filtered grayscale image thereby represents visual structures of significant extents of the grayscale image.

7. The capture engine of claim 5, wherein:

the edge image generator generates each image element of an output edge image from a plurality of corresponding elements of the input grayscale image so that the number of image elements in the output edge image is proportionally reduced from the number of image elements in the corresponding grayscale input image.

8. The capture engine of claim 1, wherein the candidate region search mechanism comprises:

a rectangular sum array generator for receiving an output edge image and generating a corresponding rectangular sum array having a sum element corresponding to each image element of the output edge image wherein each sum element represents the sum of the edge values of the image elements of a region of the output edge image bounded by a coordinate location of the output edge image and the output edge image element corresponding to the sum element, and

a rectangular sum search mechanism for examining the summed edge values represented in each of the sum elements of the rectangular sum array and identifying at least one initial candidate region having a high summed edge value, each initial candidate region thereby representing and corresponding to a region of the original image having a significant visual structure.

9. The capture engine of claim 1, wherein the candidate region adjustment and comparator mechanism comprises:

an edge adjuster for receiving the at least one initial candidate region and generating from each initial candidate region a corresponding grown candidate region by adjusting the extents of each initial candidate region to include all portions of significant visual structures having a part thereof contained within the initial candidate region, generating from each grown candidate region a corresponding edge adjusted candidate region by adjusting the extents of each grown candidate region so

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that each edge adjusted candidate region conforms to one of a set of predetermined extents for graphic icons,

comparing each edge adjusted candidate region with others of the edge adjusted candidate regions and selecting the edge adjusted candidate region having the highest amount of significant visual structure,

comparing each selected edge adjusted candidate region with previously existing graphic icons and, when the selected edge adjusted candidate region is similar to a previously existing graphic icon, selecting a next one of the at least one edge adjusted candidate regions, and,

when a selected candidate region is distinguished from the previously existing graphic icons, identifying the corresponding region of the original image for use as a graphic icon.

10. For use in a data processing system including a memory for storing programs and files containing data and a processor for operating on the data under control of the programs, a capture engine for extracting graphics information from a data file and generating a corresponding graphic icon forming a displayable image representing the graphics information, comprising:

a grayscale image generator for receiving an original image and generating a corresponding grayscale image containing brightness values representing the original image, including

a grayscale lookup table for storing grayscale brightness values corresponding to each of the possible brightness values of image elements in original images,

a grayscale converter for reading the brightness values of the image elements of the original image, reading the corresponding grayscale brightness values stored in the grayscale lookup table, and generating a corresponding grayscale image wherein each image element of the original image is represented by a grayscale image element having the grayscale brightness value corresponding to the brightness value of the image element,

an edge image mechanism for receiving the grayscale image and generating a corresponding edge image representing areas of visually significant graphic structure in the grayscale image as represented by areas of change in the brightness values, including

an edge image generator for receiving an input grayscale image and generating a corresponding output edge image wherein each image element of an output edge image is represented by an edge value proportionate to the difference between the brightness value of the corresponding image element in the input grayscale image and the brightness values of the neighboring image elements of the corresponding image element in the input grayscale image, wherein an output edge image thereby represents areas of visually significant graphic structure in the input grayscale image as represented by areas of change in the brightness values of the input grayscale image, and

a candidate region search mechanism for receiving the edge image and identifying initial candidate regions of the edge image representing visually significant areas of the original image, including

a rectangular sum array generator for receiving an output edge image and generating a corresponding

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rectangular sum array having a sum element corresponding to each image element of the output edge image wherein each sum element represents the sum of the edge values of the image elements of a region of the output edge image bounded by a coordinate location of the output edge image and the output edge image element corresponding to the sum element, and

a rectangular sum search mechanism for examining the summed edge values represented in each of the sum elements of the rectangular sum array and identifying at least one initial candidate region having a high summed edge value, each initial candidate region thereby representing and corresponding to a region of the original image having a significant visual structure, and

a candidate region adjustment and comparator mechanism for selecting a candidate region to be used in generating a corresponding graphic icon and for adjusting the selected candidate region to conform to predetermined dimensions for a graphic icon.

11. The capture engine of claim 10, wherein each image element of the original image is represented by a set of color values, the set of color values of an image element of the original element representing the color and brightness value of the image element, and wherein:

the grayscale lookup table contains a grayscale brightness value corresponding to each of the possible sets of color values of image elements in original images, and the grayscale converter is responsive to the set of color values of each image element of the original image for reading the corresponding grayscale brightness values stored in the grayscale lookup table, and generating a corresponding grayscale image wherein each image element of the original image is represented by a grayscale image element having the grayscale brightness value corresponding to the set of color values of the image element.

12. The capture engine of claim 10, wherein:

the grayscale image generator generates each image element of the grayscale image from a plurality of corresponding elements of the original image so that the number of image elements in the grayscale image is proportionally reduced from the number of image elements in the corresponding original image.

13. The capture engine of claim 10, wherein the edge image mechanism further comprises:

a lowpass filter connected between the grayscale image generator and the edge image generator for receiving a

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grayscale image and generating a corresponding filtered grayscale image of reduced resolution and provides the filtered grayscale image to the edge image generator as the correspond input grayscale image to the edge image generator, wherein

each image element of a filtered grayscale image is determined as a proportioned summation of the brightness values of selected neighboring image elements of the image element of the grayscale image, so that a filtered grayscale image thereby represents visual structures of significant extents of the grayscale image.

14. The capture engine of claim 12, wherein:

the edge image generator generates each image element of an output edge image from a plurality of corresponding elements of the input grayscale image so that the number of image elements in the output edge image is proportionally reduced from the number of image elements in the corresponding grayscale input image.

15. The capture engine of claim 10, wherein the candidate region adjustment and comparator mechanism comprises:

an edge adjuster for receiving the at least one initial candidate region and

generating from each initial candidate region a corresponding grown candidate region by adjusting the extents of each initial candidate region to include all portions of significant visual structures having a part thereof contained within the initial candidate region, generating from each grown candidate region a corresponding edge adjusted candidate region by adjusting the extents of each grown candidate region so that each edge adjusted candidate region conforms to one of a set of predetermined extents for graphic icons,

comparing each edge adjusted candidate region with others of the edge adjusted candidate regions and selecting the edge adjusted candidate region having the highest amount of significant visual structure, comparing each selected edge adjusted candidate region with previously existing graphic icons and, when the selected edge adjusted candidate region is similar to a previously existing graphic icon, selecting a next one of the at least one edge adjusted candidate regions, and,

when a selected candidate region is distinguished from the previously existing graphic icons, identifying the corresponding region of the original image for use as a graphic icon.

* * * * *



US006035055A

United States Patent [19][11] **Patent Number:** **6,035,055****Wang et al.**[45] **Date of Patent:** ***Mar. 7, 2000**

[54] **DIGITAL IMAGE MANAGEMENT SYSTEM
IN A DISTRIBUTED DATA ACCESS
NETWORK SYSTEM**

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[21] **Appl. No.:** 08/963,234

[57] **ABSTRACT**

[22] **Filed:** Nov. 3, 1997

A digital image management system is described that
includes a content analyzer that analyzes an image to extract
content data from the image. The content data of an image
include face feature data. The digital image management
system also includes an image database that is coupled to the
content analyzer to store pixel data of each of a number of
images and the content data of each of the images. A search
engine is also provided in the digital image management
system. The search engine is coupled to the image database
and the content analyzer to compare the content data of the
images with that of an input image such that any image
similar to the input image can be identified from the image
database without retrieving the pixel data of the image from
the image database. A method of extracting feature data of
a face in an image is also described.

[51] **Int. Cl.⁷** **G06K 9/00**

[52] **U.S. Cl.** 382/118; 382/190; 382/157

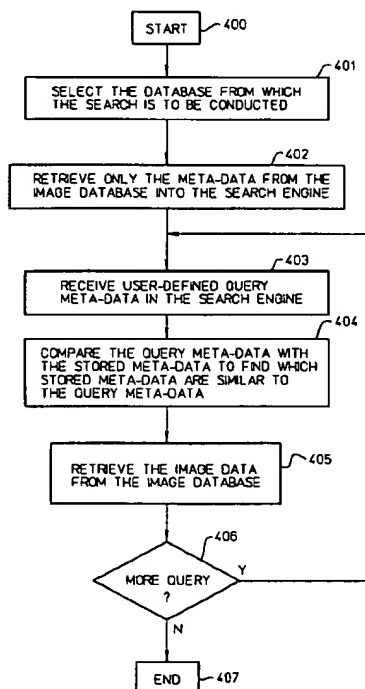
[58] **Field of Search** 382/118, 192,
382/193, 194, 201, 202, 205, 206, 208,
157, 190, 228; 356/71; 348/15

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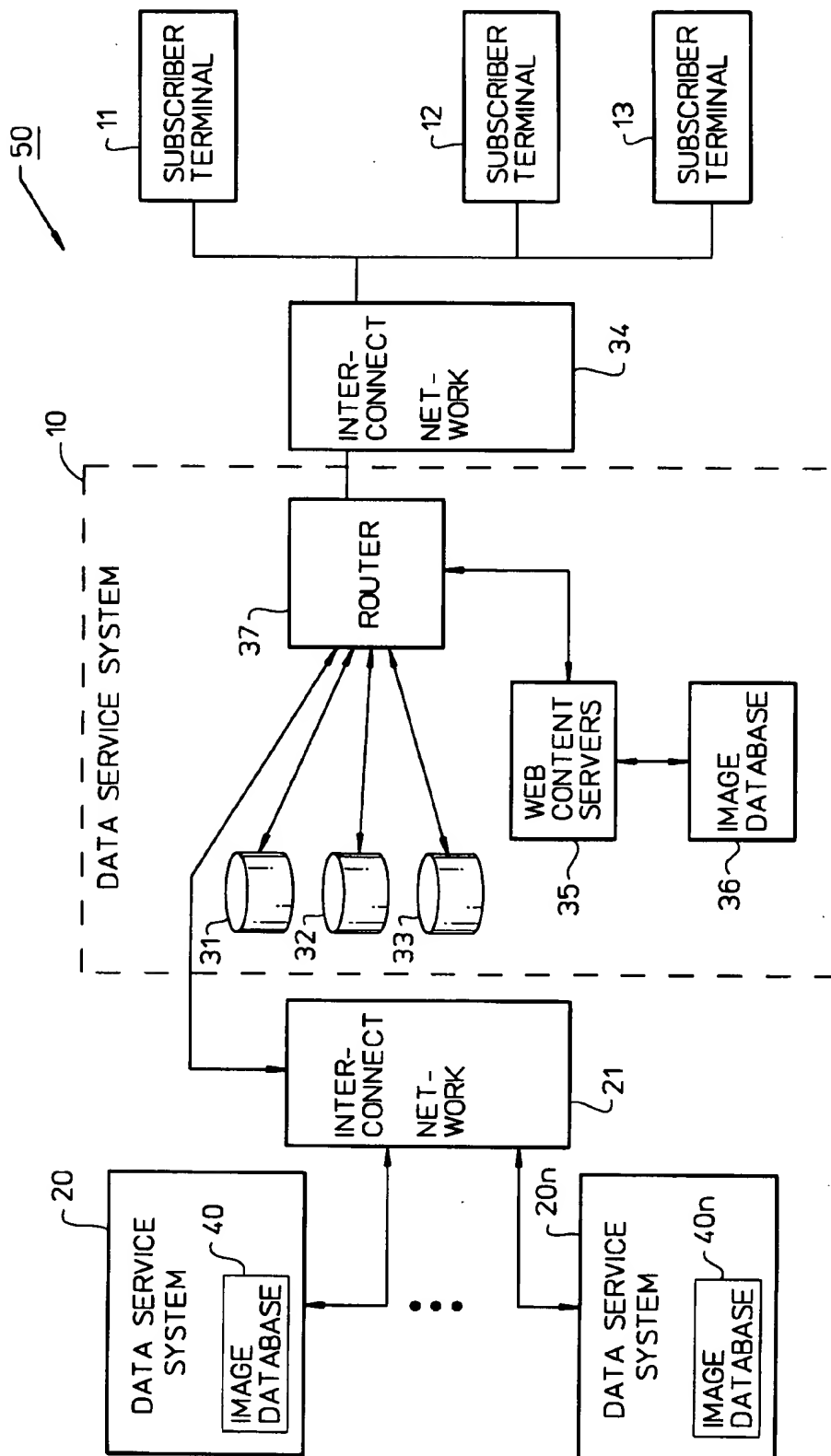
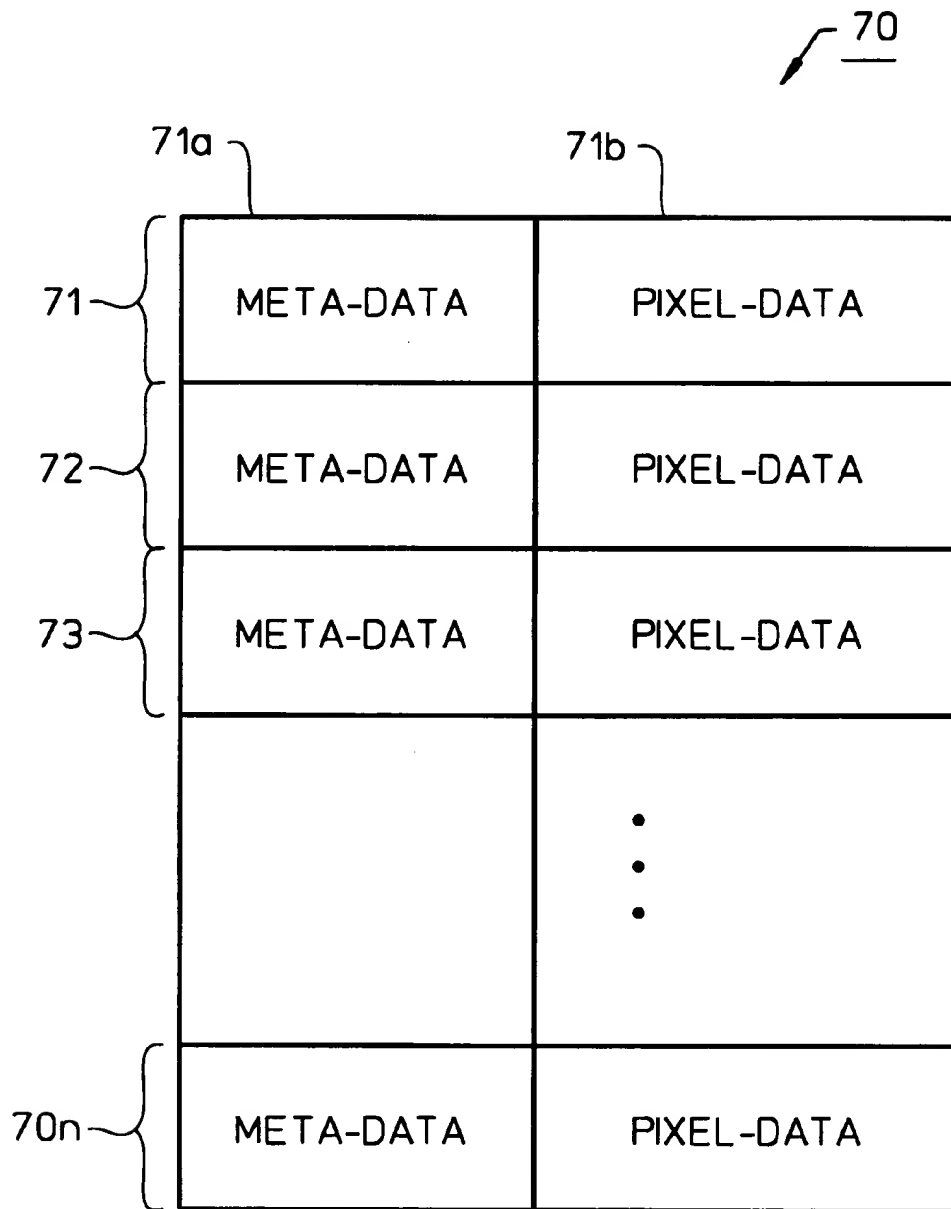
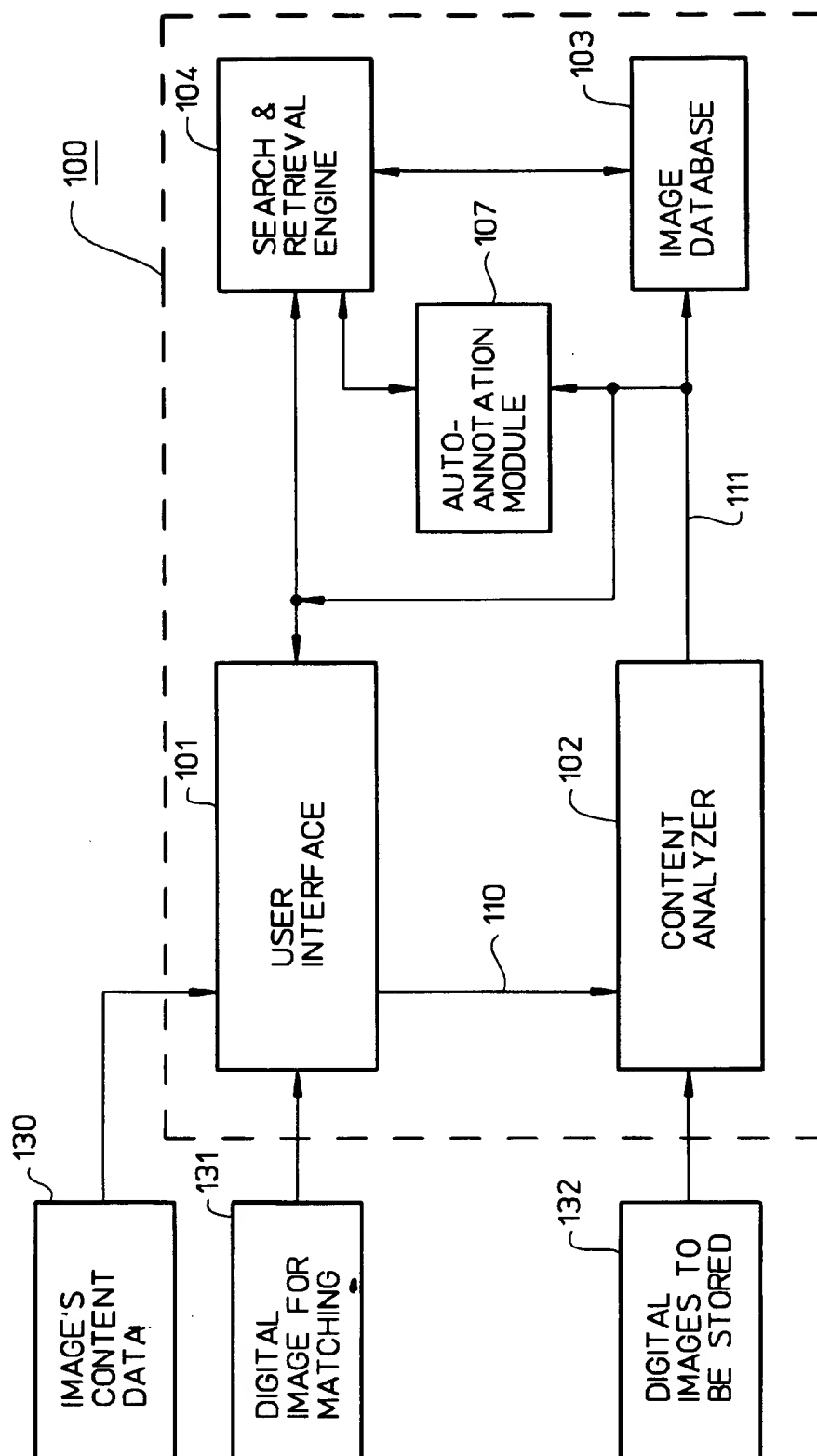


Figure 1



LOGICAL MEMORY MAP OF
THE IMAGE DATABASE

Figure 2

*Figure 3*

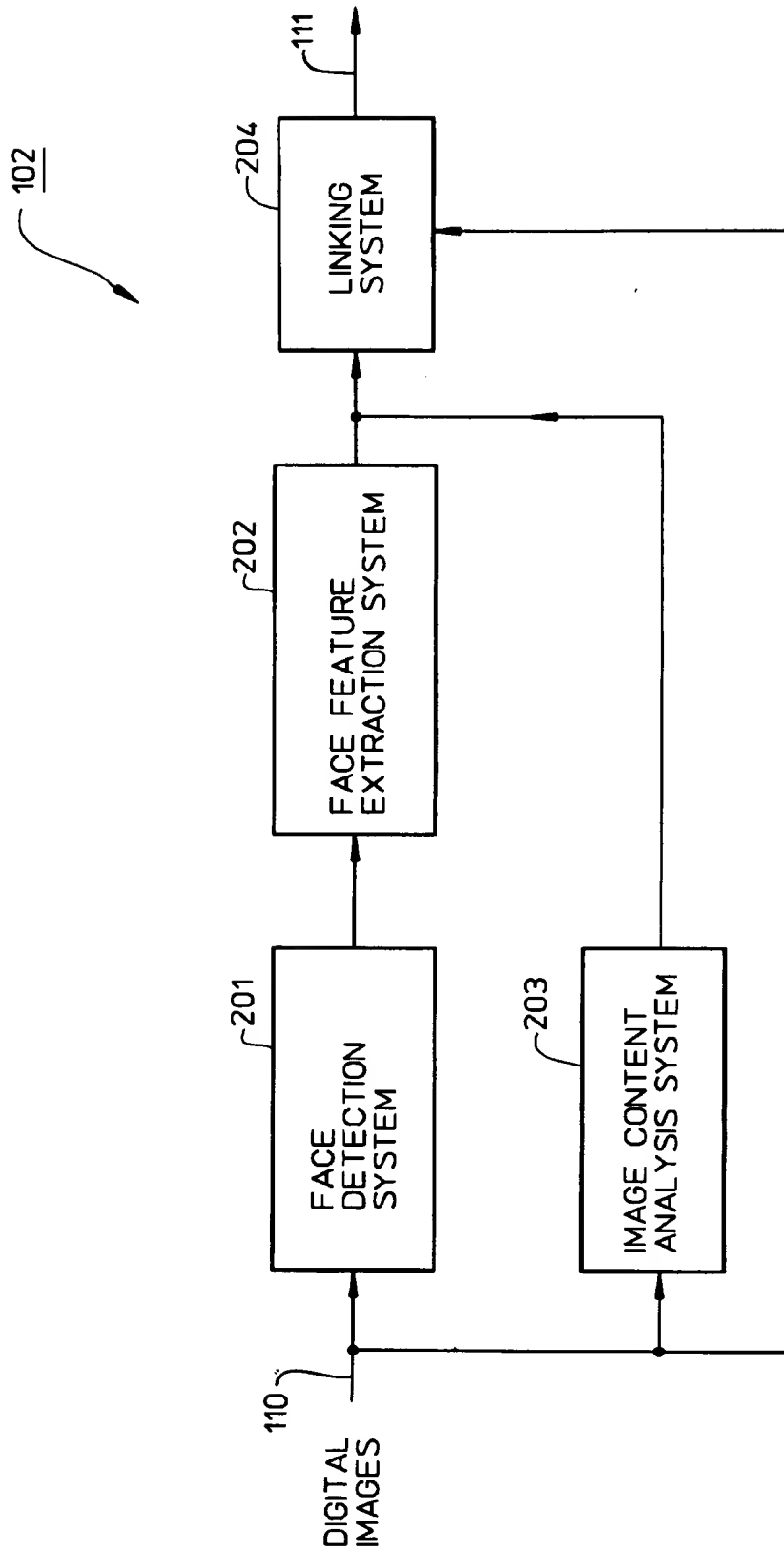
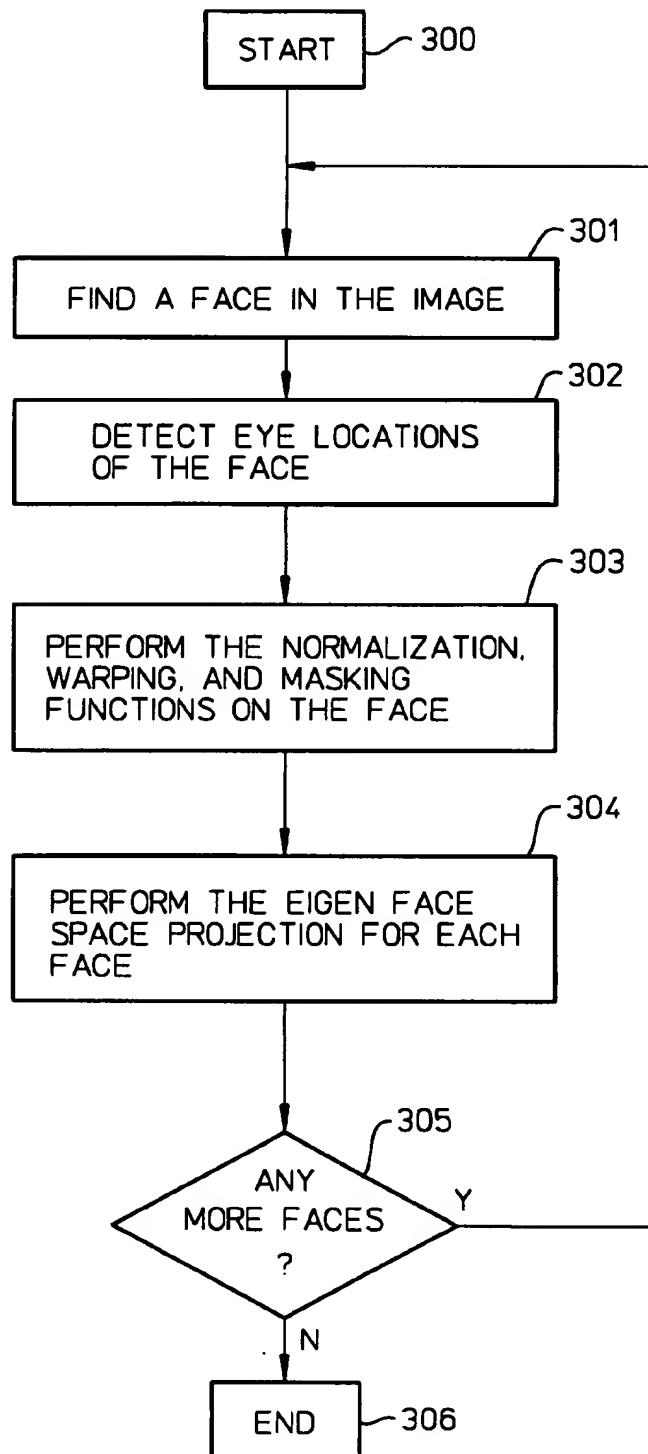
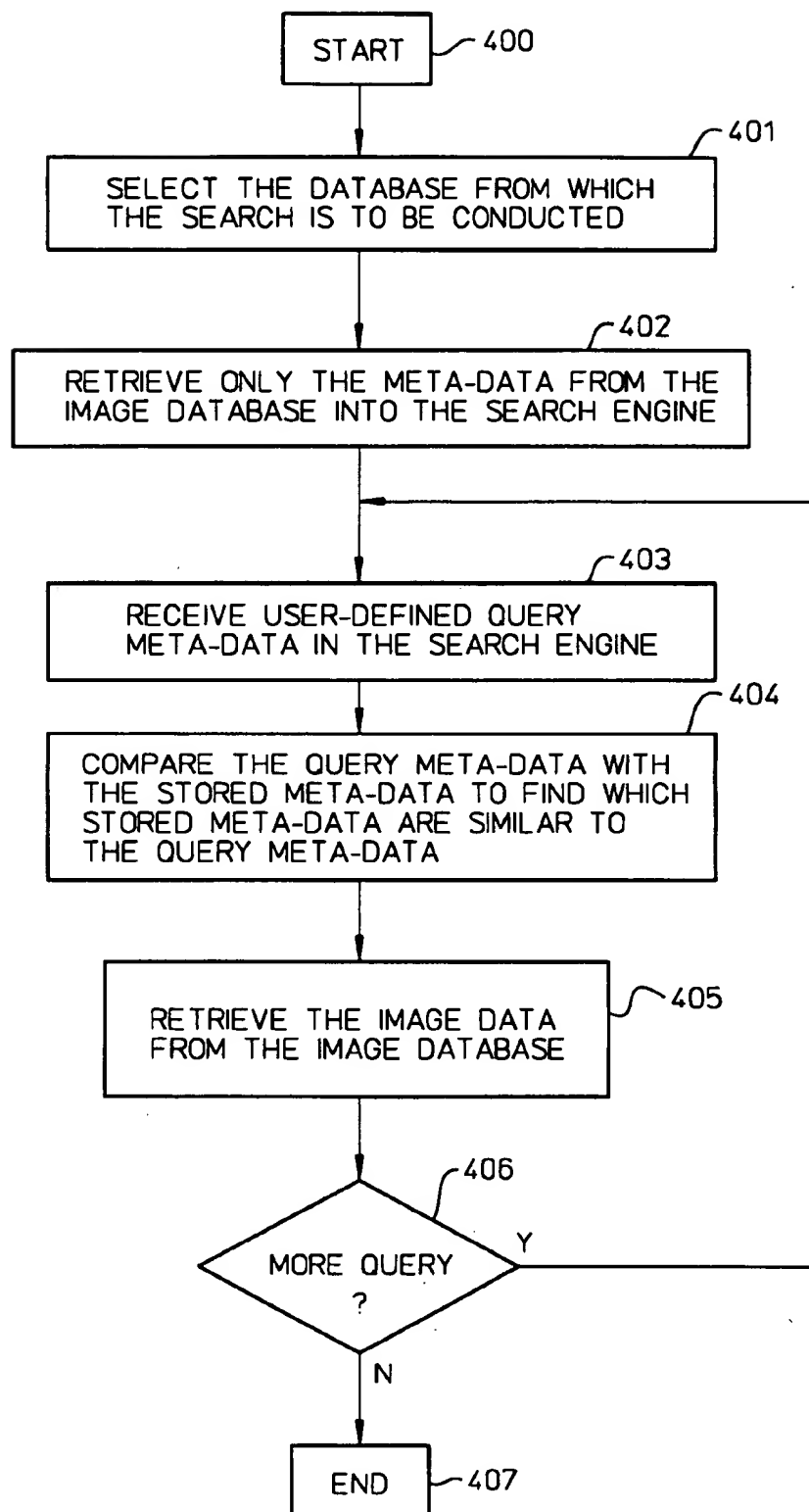


Figure 4

**Figure 5**

**Figure 6**

DIGITAL IMAGE MANAGEMENT SYSTEM IN A DISTRIBUTED DATA ACCESS NETWORK SYSTEM

BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention pertains to digital image management. More particularly, this invention relates to a digital image management system that automatically extracts content information from digital images and associates the content information with the digital images such that the digital images can be effectively and efficiently searched and retrieved.

2. Description of the Related Art

As is known, photographic prints have traditionally been used for visual presentation. The photographic prints are desirable because photographic papers are relatively inexpensive and easily portable. However, when a viewer needs to locate a desired photographic picture among a large number of pictures, the viewer has to individually view each of the pictures until the desired picture is identified. This is typically a very time consuming process. The process can also be very frustrating especially when the desired picture needs to be identified quickly.

In order to reduce the time one needs to find the desired picture among a large number of pictures, the pictures can be organized into a number of different categories. The organization typically involves labeling containers that store the pictures and building index lookup tables so that the viewer can locate the appropriate container or containers for the desired category relatively quickly. The disadvantage of this prior art approach is that a lot of time is typically spent on categorizing the pictures and arranging them according their categories. Moreover, even with this approach, the task of searching for the desired picture is still time consuming and difficult. The viewer needs to remember which picture belongs to which category in order to find the desired picture. The viewer also needs to go through the pictures within the desired category in order to identify the desired picture. Furthermore, each picture is assigned to one category.

In addition, this prior art image management system may not function properly if pictures are misplaced or miscategorized. When this occurs, the desired picture may not be identified unless all or most of the pictures have been viewed. In this case, more time is needed to find the desired picture.

With the advance of computer technologies, it is now possible to store an image in a computer system. This can be done using a scanner that converts the image on a print or film into a digital image. The digital image includes image pixels (or dots) arranged in a matrix. The data for each image pixel are then stored in the computer. The digital image can be retrieved for display from the computer. The digital image can also be digitally altered in the computer. Moreover, the digital image can be transmitted to a remote computer for viewing via a communication network. This allows real time viewing of the image.

However, searches of these digital images based on their image contents in the computer are still nearly impossible. In order to identify a desired image stored in the computer, the computer can only compare the image pixel data of an input image with the corresponding pixel data of each of the images stored in the computer. The comparison typically takes a very long time to complete and uses a lot of system

resources (e.g., memory and communication bandwidth). This is because the computer has to compare each image pixel data of the input image with the corresponding image pixel data of each of the stored images. A match occurs when each pixel data of the input image is similar the corresponding pixel data of a stored image. Using this method, unless the two compared images are very similar, it is very difficult to find a match between any two images. This is especially true because noise and other positional errors may be introduced into the image data during scanning.

SUMMARY OF THE INVENTION

One feature of the present invention is to allow image search and retrieval in a data processing system.

Another feature of the present invention is to provide a digital image management system that automatically extracts and stores content data of digital images such that effective and efficient search and retrieval of the digital images can be achieved.

A further feature of the present invention is to allow efficient image search and retrieval in a distributed data access network system.

A digital image management system is described that includes a content analyzer that analyzes an image to extract content data from the image. The content data include face feature data. The digital image management system also includes an image database that is coupled to the content analyzer to store pixel data of each of a number of images and the content data of each of the images. A search engine is also provided in the digital image management system. The search engine is coupled to the image database and the content analyzer to compare the content data of the images stored in the image database with the content data of an input image such that any image similar to the input image can be identified from the image database without retrieving the pixel data of the image from the image database.

A method of extracting feature data of a face in an image is also described. The method first detects if the image contains the face using a neural network-based face detection system. Then the feature data of the face are computed using a principle component analysis system.

In addition, the digital image management system can be implemented in a distributed data access network system that includes a number of data service systems. In this case, the content analyzer is located within one of the data service systems and the image database includes a number of databases, each being located within one of the data service systems. The search engine may include a number of search and retrieval engines, each being located within one of the data service systems.

Other features and advantages of the present invention will become apparent from the following detailed description, taken in conjunction with the accompanying drawings, illustrating by way of example the principles of the invention.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 shows a distributed data access network system that has a number of data service systems, each of which having an image database that is part of a digital image management system in accordance with one embodiment of the present invention.

FIG. 2 shows the data format of the digital images and their content data stored in each of the image databases.

FIG. 3 is a block diagram of the digital image managing system in accordance with one embodiment of the present invention.

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FIG. 4 shows the content analyzer of the digital image management system of FIG. 3, wherein the content analyzer includes a face detection system and a face feature extraction system.

FIG. 5 shows the flow chart diagram of the process of detecting faces in an image and extracting face feature data from each of the faces detected by the face detection system and the face feature extraction system of FIG. 4.

FIG. 6 shows the flow chart diagram of the process of searching and retrieving images from the image database by the search and retrieval engine of FIG. 3.

DETAILED DESCRIPTION OF THE INVENTION

FIG. 1 shows a data access network system 50 within which a digital image management system 100 (shown in FIG. 3 in block diagram form) in accordance with one embodiment of the present invention is implemented. The image management system 100 automatically extracts content data from digital images to allow the digital images stored in image databases of the data access network system 50 to be effectively and efficiently searched and retrieved. The content data include face feature data and other kinds of image content data. When the image management system 100 is implemented in a distributed network system, some of the components or modules of the image management system 100 include functionally identical units, each being within an individual system of the distributed network system.

Alternatively, the image management system 100 can be implemented within other kind of systems. For example, the image management system 100 can simply be implemented in a single computer system. Furthermore, the image management system 100 can be implemented in a computer-enabled DVD (Digital Versatile Disc) browser/player, a computer-enabled camera or scanner, or other kinds of appliances.

As will be described in more detail below and in accordance with one embodiment of the present invention, the image management system 100 allows content-based image search, querying, and browsing. The image management system 100 allows automatic extraction of content data of digital images. This allows the digital images to be efficiently and effectively searched in accordance with their content information. This also minimizes the effort required to catalog the digital images with respect to their contents. In other words, the image management system 100 effectively provides a user with access to a very large set of content-searchable images.

The image management system 100 analyzes an image to extract the content data from the image with a content analyzer 102. The content data of the image include color data of the image, texture data of the image, face feature data of the image, shape and position data of objects within the image, and other feature data of the image. In addition, the content data may also include text description data of the image. The content data can be referred to as meta-data. The content analyzer 102 extracts the face feature data by first detecting if the image contains one or more faces using a face detection system 201 (see FIG. 4). Then the content analyzer 102 computes the feature data of each of the faces in the image using a face feature extraction system 202 (see FIG. 4).

The content data of an image are then stored in one of the image databases (e.g., the image databases 36 and 40 through 40n of FIG. 1) of the image management system

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100, in association with the pixel data of the respective image. The content data and the pixel data of a particular image may be stored in different image databases. When this occurs, the logical links (e.g., hyper-links) between the content data and the pixel data are stored into one of the image databases. The content analyzer 102 performs this function using a linking system 204 (see FIG. 4).

When the image management system 100 receives an image for browsing, querying, or comparison, the content data of the new image are extracted and compared with that of the images stored in the image databases of the image management system 100 based on a predetermined similarity measure such that any image similar to the input image can be identified from the image databases without viewing the images. The search results can be ranked, for example, according to similarity scores.

In addition, the image management system 100 can receive the content data (instead of the actual image) to search for any image stored in the image databases of the system 100 that has similar content data. The comparison is done by a search engine 104 of the image management system 100. In one embodiment, the search engine 100 retrieves the pixel data of the similar images after the search is completed. In another embodiment, the search engine 104 only retrieves the content data of the similar images to produce the ranked list. In this case, the search engine 104 retrieves the pixel data of the similar images only when display of the images is requested by the user.

Moreover, the image management system 100 also includes a labeling capability that allows the user to associate personal information (e.g., name) with a face in an image. This is done by an auto-annotation module 107 of the image management system 100. The image management system 100 will be described in more detail below, also in conjunction with FIGS. 1-6.

Referring now to FIG. 1, the data access network system 50 that embodies the digital image management system 100 is described in more detail. In one embodiment, the data access network system 50 is a distributed or federated network system that spans multiple independently administered control domains. This means that the system 50 is an open system that includes different administrative entities cooperating together as a network. Alternatively, the data access network system 50 can have other network architectures. For example, the data access network system 50 may be a closed network system.

The data access network system 50 includes a number of data service systems 10 and 20 through 20n that are connected together via an interconnect network 21. Each of the data service systems 10 and 20-20n can be an Internet/Intranet service system in one embodiment. This means that each of the data service systems 10 and 20-20n contains the same logical structure. Therefore, only the data service system 10 will be described in more detail below.

The data service system 10 is further connected to subscriber sites 11-13 via an interconnect network 34. Included in the data service system 10 are a router 37, content servers 35, proxy servers 31, DNSs (Domain Name Servers) 32, and DHCP (Dynamic Host Configuration Protocol) servers 33. The router 37 is used for routing data to and from the subscriber sites 11-13 upon receiving a request from a subscriber/user. The router 37 also directs data traffic to the appropriate servers 31-33 and 35, or to the other data service systems 20-20n. The content servers 35 support a variety of Internet applications, including World Wide Web access, electronic mail, bulletin boards, news groups and FTP

access. The proxy servers 31 may be used to enhance security of accesses to and from the subscriber sites 11-13, as well as to speed up Internet access to other data service systems 20-20n from the data service system 10 by caching frequently accessed data locally. All of the servers 31-33 and 35 are well known in the art.

The data service system 10 can be implemented by a single computer system or a number of computer systems connected together. When the data service system 10 is implemented by a single computer system, each of the components 31-33 and 35-37 is within the computer system. When the data service system 10 is implemented by a number of computer systems, each computer system can include one or more of the components 31-33 and 35-37.

The data service system 10 provides, for example, Internet or Intranet service to subscriber sites 11 through 13 via the interconnect network 34. This means the data access network system 50 is an Internet or Intranet network system. FIG. 1 only shows the subscriber sites 11-13 for illustration purposes. In practice, many more sites may be connected to the data service system 10.

The subscriber sites 11-13 may include terminals of subscribers/users located at the residences, schools, or offices of the subscribers/users. The interconnect network 34 can be any known network. For example, the interconnect network 34 can be the telephone network system.

Each of the subscriber sites 11-13 may include a personal computer, a network computer, a notebook computer, a workstation, a mainframe computer, a supercomputer, or any other type of data processing system. Moreover, each of the subscriber sites 11-13 may be a multi-media web TV or a web-enabled smart video player or scanner.

As can be seen from FIG. 1, each of the data service systems 10 and 20-20n includes an image database. For example, the data service system 10 includes the image database 36 and the data service system 20 includes the image database 40. The image databases 36 and 40-40n are part of the image management system 100 of FIG. 3 when the image management system 100 is implemented within the data access network system 50.

Each of the image databases 36 and 40-40n can be accessed from, for example, one of the subscriber sites 11-13 via the content servers of the respective data service system. Each of the image databases 36 and 40-40n stores a number of digital images and their content data. Each of the digital images stored is, for example, in the pixel matrix format in the respective image database. The content data of each image are associated with the respective digital image stored in the image database, but are not necessarily physically stored adjacent to the respective image in the image database. FIG. 2 shows the logical memory map 70 for the digital images stored in any of image databases 36 and 40-40n.

As can be seen from FIG. 2, the logical memory map 70 includes a number of entries 71-70n, each for storing one digital image. Each entry (e.g., the entry 71) includes a content data field (e.g., the content data field 71a) and an image field (e.g., the image field 71b). The content data field of each entry stores the content data of a digital image and the image field stores the image data of the digital image. The content data field of an entry is associated or linked to the image field of that entry.

Referring back to FIG. 1, because the data service systems 10 and 20-20n are connected together, a subscriber site connected to any of the data service systems 10 and 20-20n can access and retrieve the digital images stored in any of the

image databases 36 and 40-40n. Because each digital image stored in an image database of the databases 36 and 40-40n contains both its pixel data and content data, the user at the subscriber site may only retrieve the content data, the pixel data, or both from the respective image database. This means when the image management system 100 of FIG. 3 is implemented in the data access network system 50, the search and retrieval are effective and efficient because only the content data of digital images need to be downloaded from one of the image databases 36 and 40-40n. The image management system 100 will be described in more detail below, also in conjunction with FIGS. 3-6.

Referring now to FIG. 3, the image management system 100 includes a user interface 101 and an image database 103, in addition to the content analyzer 102 and the search and retrieval engine 104. The image database 103 collectively represents the image databases 36 and 40-40n of FIG. 1 when the image management system 100 is employed in the data access network system 50.

In one embodiment, each of the components 101-102 and 104 is a functional component and is implemented by software. In another embodiment, each of the components 101-102 and 104 can be discrete hardware or firmware module.

Referring to FIGS. 1 and 3, when the image management system 100 is implemented in the data access network system 50, the image database 103 and the search engine 104 are implemented in each of the data service systems while the user interface 101 and the content analyzer 102 are implemented in a subscriber site (e.g., the subscriber site 11) in one embodiment. In another embodiment, all components except the image database 103 are implemented in a subscriber site. Alternatively, all components of the image management system 100 except the user interface 101 can be implemented in one of the data service systems (e.g., the data service system 10) of the data access network system 50 while the user interface 101 is implemented in the subscriber site.

Referring to FIG. 3, the content analyzer 102 is connected to the user interface 101 and the image database 103. The user interface 101 is also connected to the search and retrieval engine 104. The search and retrieval engine 104 is in turn connected to the image database 103. The search and retrieval engine 104 is also connected to the auto-annotation module 107. The content analyzer 102 is used to analyze each digital image it receives to extract content information from the image. The content analyzer 102 also stores the logical link (e.g., hyper-link) information between the content data and the pixel data of an image into the image database 103 if the content data and the pixel data of the image are stored in separate locations or databases of the image database 103. FIG. 4 shows in more detail the content analyzer 102, which will be described in more detail below.

Referring again to FIG. 3, the content analyzer 102 receives the digital images 132 to be stored in the image database 103. The content analyzer 102 can also receive the digital image 131 from the user interface 101. The digital images 132 are fed to the content analyzer 102 from, for example, a storage means (not shown in FIG. 3). The digital images 132 can be acquired by scanning photos or pictures using a scanner, or by a digital camera. In one embodiment, the content analyzer 102 receives one digital image at one time. In an alternative embodiment, the content analyzer 102 can receive and process a number of digital images at the same time.

The user interface 101 is an interactive user interface that is part of an interactive window interface. The user interface

101 includes a window (not shown) that displays the digital image 131 or the content data 130. The image management system 100 uses the digital image 131 to search for any similar images stored in the database 103. When the content data 130 are used for the search instead of the digital image 131, the image management system 100 searches the image database 103 for any image having similar content data to the content data 130. When the content data 130 are associated with the digital image 131, the image management system 100 can use the content data 130 to directly search the database 103.

The user interface 101 also displays the search results (e.g., the digital images that are found to be similar based on the similarity scores). In addition, the user interface 101 also includes a number of command or function buttons that can be activated using a user input device (e.g., mouse).

If the digital image 131 includes a number of faces, the user interface 101 allows the user to select one of the faces in the image 131 for processing. This allows the content analyzer 102 to compute the content data of the selected face or select the associated face meta-data from the content data 130. The search and retrieval engine 104 then searches for any images stored in the database 103 that contains faces similar to the selected face in the digital image 131. The face selection can be done by the user using the user input device in a conventional way.

In addition, the user interface 101 also allows display of multiple images and retrieval based on faces present in those multiple images. In this case, the user interface 101 allows the user to select and combine faces from different images displayed for the search. For example, the user can, through the user interface 101, select faces in different images and combine the selected faces together for a boolean search (i.e., at least one, AND, or OR).

Once the user selects the desired function or operation, the user interface 101 notifies the corresponding components for the appropriate operation. The user interface 101 can be implemented by any known interactive user interface technology.

The user interface 101 receives the digital image 131 (or a number of images) to be searched. The digital images 131 can be acquired by scanning photos or pictures using a scanner, or by a digital camera. This means that the user interface 101 is connected to an image capturing device (e.g., a scanner or digital camera) (not shown in FIG. 4). The user interface 101 can also receive the content data 130 of an image.

The search and retrieval engine 104 is used to receive the content data of a digital image and uses the content data to search the image database 103 for images with the same or similar content data. As described above, the content data include face feature data, color data, texture data, shape and position data, and/or text description data of the image.

In one embodiment, the search and retrieval engine 104 uses the face feature data to search for images stored in the image database 103 having similar face feature data. In another embodiment, the search and retrieval engine 104 combines the face feature data with other kinds of the content data (e.g., the color data, texture data, shape and position data, and/or text description data) to search for images stored in the image database 103.

In one embodiment, the search and retrieval engine 104 only uses one kind feature data (e.g., the face feature data or the color and texture feature data) to search for the similar images. In another embodiment, the search and retrieval engine 104 combines the face feature data with all other feature data of the content data for the search.

In one embodiment, the search and retrieval engine 104 retrieves the content data of all digital images from the image database 103 into the engine 104. The search and retrieval engine 104 then compares the content data with the content data of the digital image 131 or the content data 130 to output similarity scores between the two content data based on the predetermined similarity measure. In one embodiment, the similarity measure includes a set of thresholds and the content data include a set of values. The comparison of the corresponding values of two content data yields differences between the values of the two content data. The differences are then compared against their corresponding thresholds. A similarity score is obtained based on how many of the differences are less or more than the thresholds. The search and retrieval engine 104 can be any kind of known search engine.

In one embodiment, the search and retrieval engine 104 retrieves both the content and pixel data of the similar images for display after a search. In another embodiment, the search and retrieval engine 104 selectively retrieves the similar images in accordance with their similarity scores. In a further embodiment, the search and retrieval engine 104 retrieves the pixel data of the similar images only when display of these images is requested.

In addition, the search and retrieval engine 104 may include a number of search and retrieval engines, each of which is located in one of the data service systems 10 and 20-20n (FIG. 1). When this is the case, the search engine 104 allows retrieval of the pixel data of the similar images stored in the local image database of the image database 103 while allowing the retrieval of only the content data of the similar images stored in the external image databases of the image database 103 into the local data service system.

When one of the digital images 132 is to be stored in the image database 103, the image is sent to the content analyzer 102 to extract the content data from the image. The image and its content data are linked together and stored in the image database 103. When the digital image 131 is received in the user interface 101, the user interface 101 first sends the image 131 to the content analyzer 102 to extract the content data from the digital image 131. The content data are sent to the search and retrieval engine 104 to be compared with the content data stored in the image database 103. The references to the content data matching the content data of the digital image 131 are then sent back to the user interface 101. The user can then decide whether to view those images associated with those content data. If the user interface 101 receives the image content data 130 (i.e., content query) instead of the digital image 131, the user interface 101 directly sends the content data 130 to the search and retrieval engine 104.

The image management system 100 also includes an auto-annotation module 107 that is connected to the search and retrieval engine 104. The auto-annotation module 107 associates personal information (e.g., name) of a first face within a first image already stored in the image database 103 with a second image having a second face that is found to be similar to the first face. The faces are found similar because, for example, they have matching or similar face feature data. This allows linking of images having different "faces" of the same person. After the auto-annotation module 107 links the personal information with the second image, the second image may then be stored in the image database 103.

The image management system 100 simplifies the management of digital images, resulting a large set of content-indexed images. It also provides efficient and effective

search and retrieval for digital images. This, for example, reduces the time of finding a desired image for printing or transmission to a remote site for viewing. In other words, the image management system 100 greatly simplifies the access to available images. In addition, the image management system 100 provides a virtual distributed image database.

FIG. 4 shows the structure of the content analyzer 102. As can be seen from FIG. 4, the content analyzer 102 includes a face detection system 201, a face feature extraction system 202, and an image content analysis system 203. In addition, the content analyzer 102 also includes a linking system 204 that associates the extracted content data with the respective digital image. The linking system 204 provides the logical linking information between the content data of an image and the pixel data of the image. The logical linking information can be, for example, hyper-links. In this case, the content data and the pixel data of the image can be stored in different locations within a database, or even in different databases of the image database 103. Alternatively, the content analyzer 102 does not include the linking system 204. In this case, the linking or association function is performed in the image database 103 where the image and its content data are stored.

The face detection system 201 is connected to receive the digital images 132 and the digital image 131 via the user interface 101 of FIG. 3. The face detection system 201 detects if the digital image received contains any face. If the image contains a number of faces, the detection system 201 detects each of the faces. The face detection system 201 detects the eye locations of a face if the image contains the face. The image data and the faces' eye location data are sent to the face feature extraction system 202 to compute the face feature data of the detected face. The face feature data are also referred to as face coefficient data. When multiple faces are detected, the face feature extraction system 202 extracts the face feature data of each of the faces and the respective data are associated with that face in that image.

In one embodiment, the face detection system 201 is a neural network-based face detection system disclosed in a publication entitled HUMAN FACE DETECTION IN VISUAL SCENES, by H. Rowley (har@cs.cmu.edu), S. Baluja (baluja@cs.cmu.edu), and T. Kanade (tk@cs.cmu.edu) in November 1995. The publication is available from Carnegie Mellon University's Internet site at "www.ius.Cs.cmu.edu/IUS/har2/har/www/CM U-CS-95-158R/." Alternatively, other known face detection systems may be used for the face detection system 201.

When the face detection system 201 is the neural network-based face detection system, the face detection system 201 detects if the image contains any face by first applying a set of neural network-based filters to the image. The filters examine each location in the image at several scales, looking for locations that might contain a face (i.e., looking for eye locations). The face detection system 201 then uses an arbitrator to combine the filter outputs. The arbitrator is used to merge detections from individual filters and eliminate overlapping detections. Using the neural network-based face detection system as the face detection system 201 makes the face detection robust, relatively fast, and detect most faces. In addition, it allows the face detection system 201 to detect different kinds of faces with different poses and lightings.

Once a face is detected from an image, the image and the eye locations of the face are sent to the face feature extraction system 202. In one embodiment, the face feature extraction system 202 is implemented by a face feature

extraction system described in U.S. Pat. No. 5,164,992, dated Nov. 17, 1992, and entitled FACE RECOGNITION SYSTEM. Alternatively, other known face feature extraction systems may be used.

The face feature extraction system 202 extracts the face feature data from the detected face. The face feature extraction system 202 does this by first normalizing, warping (i.e., rotating and scaling), and masking the face to produce a reference face that has a set of predetermined eye locations. This means that through normalizing, warping, and masking of the detected face, the eyes of the detected face are mapped into the predetermined eye locations of the reference face. This is done by translating, scaling, and rotating the detected face and by adjusting the brightness and contrast of the detected face. In other words, this is to standardize or normalize the detected face. This is disclosed in the above-mentioned U.S. Pat. No. 5,164,992.

Then the face feature extraction system 202 projects the standardized face into an Eigen face space to compute the face coefficients of the detected face. This is also disclosed in the above-mentioned U.S. Pat. No. 5,164,992.

FIG. 5 shows the process of detecting faces in an image and extracting the face feature data from the detected face by the face detection system 201 and the face feature extraction system 202 of FIG. 4. As can be seen from FIG. 5, the steps 301 and 302 are performed by the face detection system 201 of FIG. 4 and the steps 303 and 304 are performed by the face feature extraction system 202 of FIG. 4. At the steps 301-302, the face detection system 201 detects if the image contains a face and, if so, the eye locations of the face. At the step 303, the face feature extraction system 202 of FIG. 4 performs the normalization, wrapping, and masking functions on the detected face. This essentially maps the detected face into a reference face such that the eyes of the detected face are mapped into the predetermined eye locations of the reference face.

Referring back to FIG. 4, the digital image applied to the face detection system 201 is meanwhile also applied to the image content analysis system 203. The image content analysis system 203 analyzes the image and extracts visual content data from the digital image. The visual content data include color, texture, shape, and position data of the content data. The color and texture data indicate properties such as color percentages, color layout, color histogram, color moment, color coherence, texture compactness, texture contrast, texture directionality, texture periodicity, and texture homogeneity. In one embodiment, the image content analysis system 203 is implemented by a QBICTM (Query By Image Content) system manufactured and sold by IBM Corporation of Armonk, New York. The QBICTM system can be downloaded from IBM's world wide web site at "www.qbic.almaden.ibm.com." Alternatively, the image content analysis system 203 can be implemented by other known color and texture extraction systems.

In one embodiment, the image content analysis system 203 also receives text description data of the image from the user interface 101 (FIG. 3). The text description data are supplied by the user through the user interface 101. The content analysis system 203 adds the text description data into the content data.

The image and its extracted content data from the image content analysis system 203 and the face feature extraction system 202 are then sent to the linking system 204 such that they can be associated with each other before being stored in the image database 103 of FIG. 3, or being sent to the search and retrieval engine 104. As described above, the

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linking system 204 also provides the logical linking information of the content data and the pixel data of the image when they are stored at separate locations.

FIG. 6 shows the process performed by the searching and retrieval system 104 of FIG. 3 for searching and retrieving the digital images from the image database 103. As can be seen from FIG. 6, at the step 401, the image database or databases from which the search is to be conducted are selected. At the step 402, the content data of all the digital images stored in the selected database or databases are retrieved. In one embodiment, the content data of an image also include a low resolution version of the image that functions as an icon of the image. Alternatively, the content data do not include such icons.

At the step 403, the user-defined query content data (i.e., the content data 130 or the content data of the digital image 131 of FIG. 3) are sent to the search and retrieval engine 104. Then the query content data are compared with the stored content data. Any stored content data matching or similar to the query content data are identified and their corresponding images retrieved at the step 405. Alternatively, the search engine 104 of FIG. 3 only sends the icon data of those matching content data to the user interface 101 for display. At step 406, it is determined if more queries are received for comparison. Alternatively, only the references to the matching images are sent to the user interface 101. In this case, the icon data or image data are sent later when display of these images is requested. If not, the process ends at the step 407. Otherwise, the steps 403-405 are repeated.

In the foregoing specification, the invention has been described with reference to specific embodiments thereof. It will, however, be evident to those skilled in the art that various modifications and changes may be made thereto without departing from the broader spirit and scope of the invention. The specification and drawings are, accordingly, to be regarded in an illustrative rather than a restrictive sense.

What is claimed is:

1. A digital image management system, comprising:

- (A) a content analyzer that analyzes an input image to extract content data from the image, wherein the content data include face feature data, color data, and texture data of the entire image, as well as shape and position data of objects within the image, wherein the content analyzer further comprises
 - a neural network-based face detection system that detects if the image contains a face;
 - a principle component analysis system that computes the face feature data from the detected face within the image by (1) standardizing the face and (2) projecting the standardized face into an Eigen face in order to compute the face feature data, wherein the computed face feature data are not a low resolution sub-image of the detected face;

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an image content analysis system that extracts the color data, texture data of the image, and shape and position data of objects within the image;

- (B) an image database coupled to the content analyzer to store pixel data of each of a plurality of images and the content data of each of the images associated with that image;
- (C) a search engine coupled to the image database and the content analyzer to compare the content data of the images with the content data of the input image such that any image similar to the input image can be identified from the image database without retrieving the pixel data of the image from the image database, wherein the search engine combines the face feature data of the input image with the color data, the texture data, and the shape and position data of the image to search the image database.

2. The digital image management system of claim 1, wherein the neural network-based face detection system detects if the image contains a face by dividing the image into a plurality of small windows and determining whether each of the windows contains a face, wherein the image may include a plurality of faces.

3. The digital image management system of claim 1, wherein the principle component analysis system extracts the face feature data of the face by normalizing the face into a standardized face such that eyes of the standardized face lie at predetermined locations in a reference map, and then computing the face feature data corresponding to the standardized face.

4. The digital image management system of claim 3, wherein the principle component analysis system normalizes the face into the standardized face by translating, scaling, and rotating the face and by adjusting brightness and contrast of the face.

5. The digital image management system of claim 1, wherein the image content analysis system extracts color percentage, color layout, and texture of the image to extract the color and textual data.

6. The digital image management system of claim 1, further comprising a user interface that displays the input image, wherein when the input image includes a plurality of faces, the user interface allows a user to select at least one of the faces within the image to be searched by the search engine.

7. The digital image management system of claim 1, further comprising an auto-annotation module coupled to the search engine to associate personal information of a first face within a first image stored in the image database with a second image having a second face that is similar to the first face of the first image.

* * * * *



US005987454A

United States Patent [19]
Hobbs

[11] **Patent Number:** **5,987,454**
 [45] **Date of Patent:** **Nov. 16, 1999**

[54] **METHOD AND APPARATUS FOR SELECTIVELY AUGMENTING RETRIEVED TEXT, NUMBERS, MAPS, CHARTS, STILL PICTURES AND/OR GRAPHICS, MOVING PICTURES AND/OR GRAPHICS AND AUDIO INFORMATION FROM A NETWORK RESOURCE**

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[21] **Appl. No.:** 08/871,773

[22] **Filed:** Jun. 9, 1997

[51] **Int. Cl.⁶** G06F 17/00

[52] **U.S. Cl.** 707/4; 707/201; 707/101; 707/501; 707/10

[58] **Field of Search** 707/1-206, 501-513

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Primary Examiner—Thomas G. Black

Assistant Examiner—David Yuik Jury

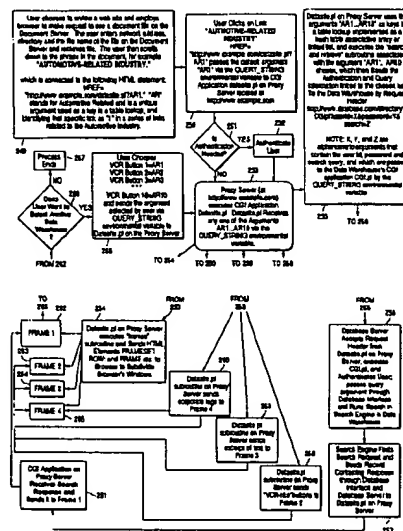
Attorney, Agent, or Firm—Coudert Brothers

[57]

ABSTRACT

Apparatus and method are disclosed for selecting multimedia information, such as video, audio, graphics and text residing on a plurality of Data Warehouses, relational database management systems (RDMS) or object-oriented database systems (ODBA) connected to the Internet or other network, and for linking the multimedia information across the Internet, or other network, to any phrase, word, sentence and paragraph of text; or numbers; or maps; charts, and tables; or still pictures and/or graphics; or moving pictures and/or graphics; or audio elements contained in documents on an Internet or intranet web site so that any viewer of a web site, or other network resource, can directly access updated information in the Data Warehouse or a database in real time. The apparatus and method each: (i) stores a plurality of predetermined authentication procedures (such as user names and passwords) to gain admittance to Data Warehouses or databases, (ii) stores the Universal Resource Locators of intranet and Internet addresses of a plurality of expert predetermined optimum databases or Data Warehouses containing text, audio, video and graphic information, or multimedia information relating to the information on the web site or other network resource; (iii) stores a plurality of expert-predetermined optimum queries for use in the search engines of each of the pre-selected databases, each query representing a discrete searchable concept as expressed by a word, phrase, sentence or paragraph of text, or any other media such as audio and video on a web site, or other network resource; and (iv) presents to the user the results of a search of the Data Warehouse or database through a graphical user interface (GUI) which coordinates and correlates viewer selection criteria with the expert optimum remote database selection and queries.

61 Claims, 17 Drawing Sheets



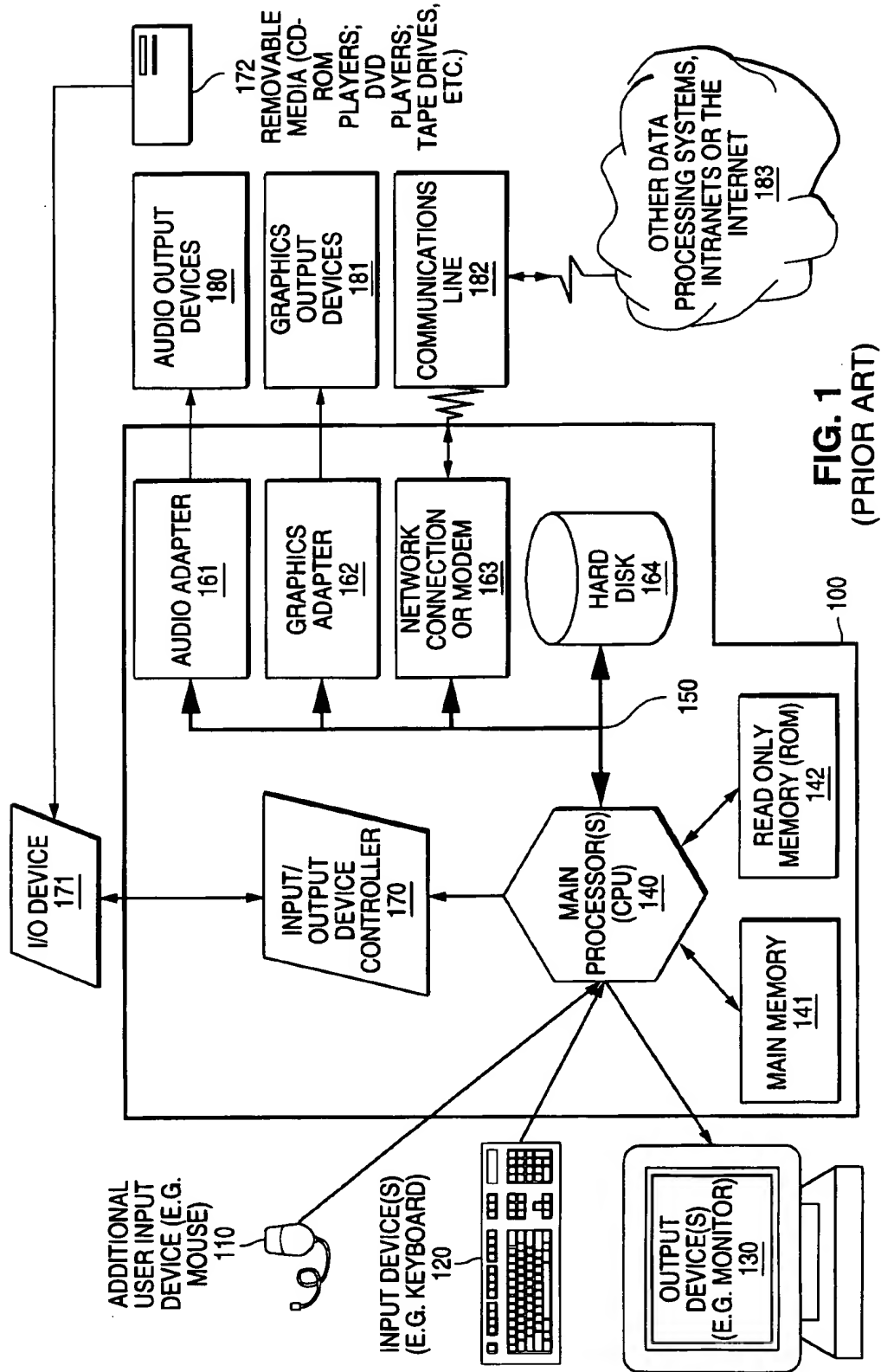


FIG. 1
(PRIOR ART)

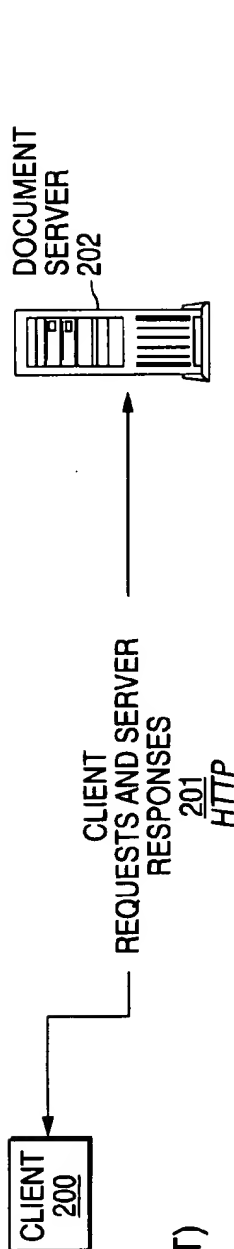


FIG. 2
(PRIOR ART)

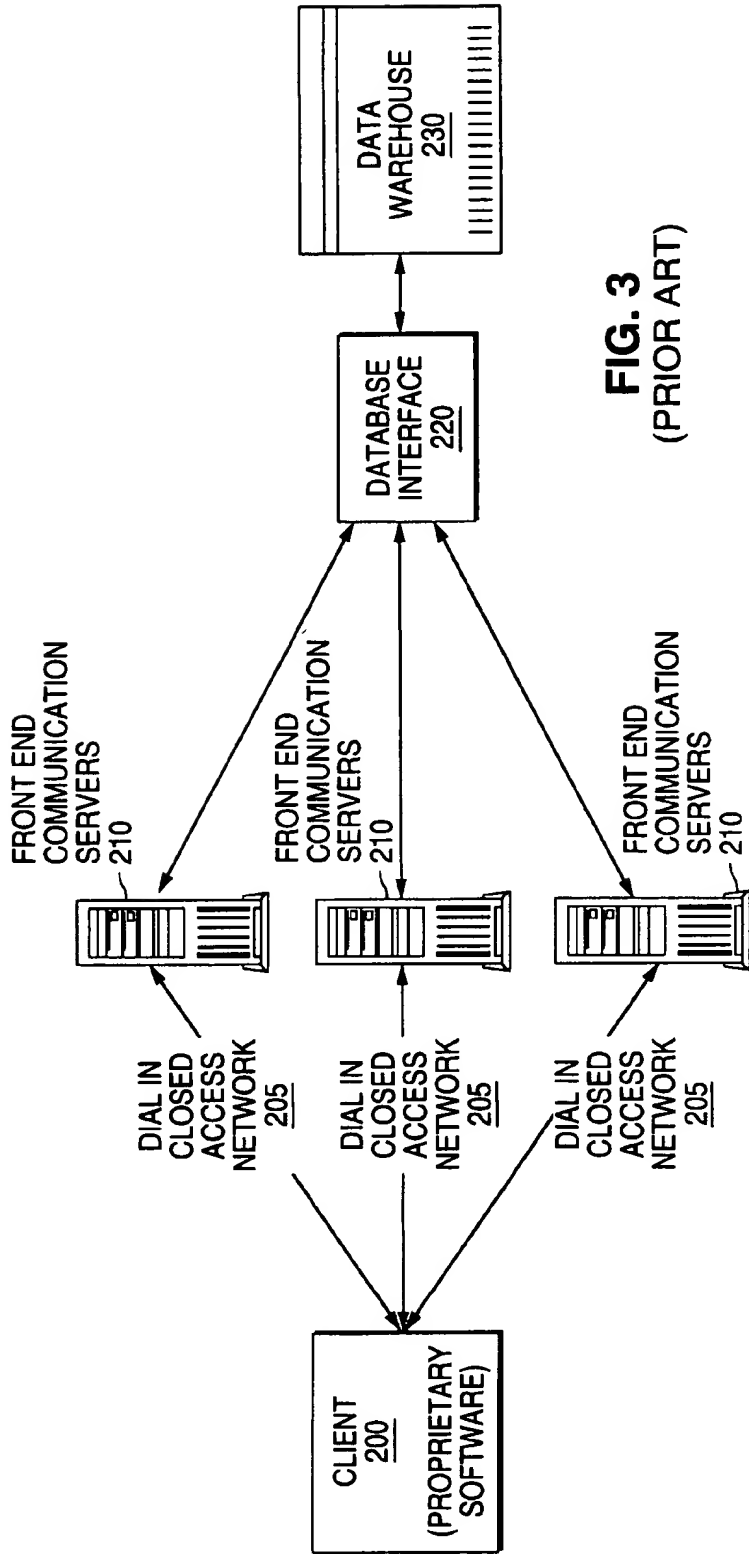


FIG. 3
(PRIOR ART)

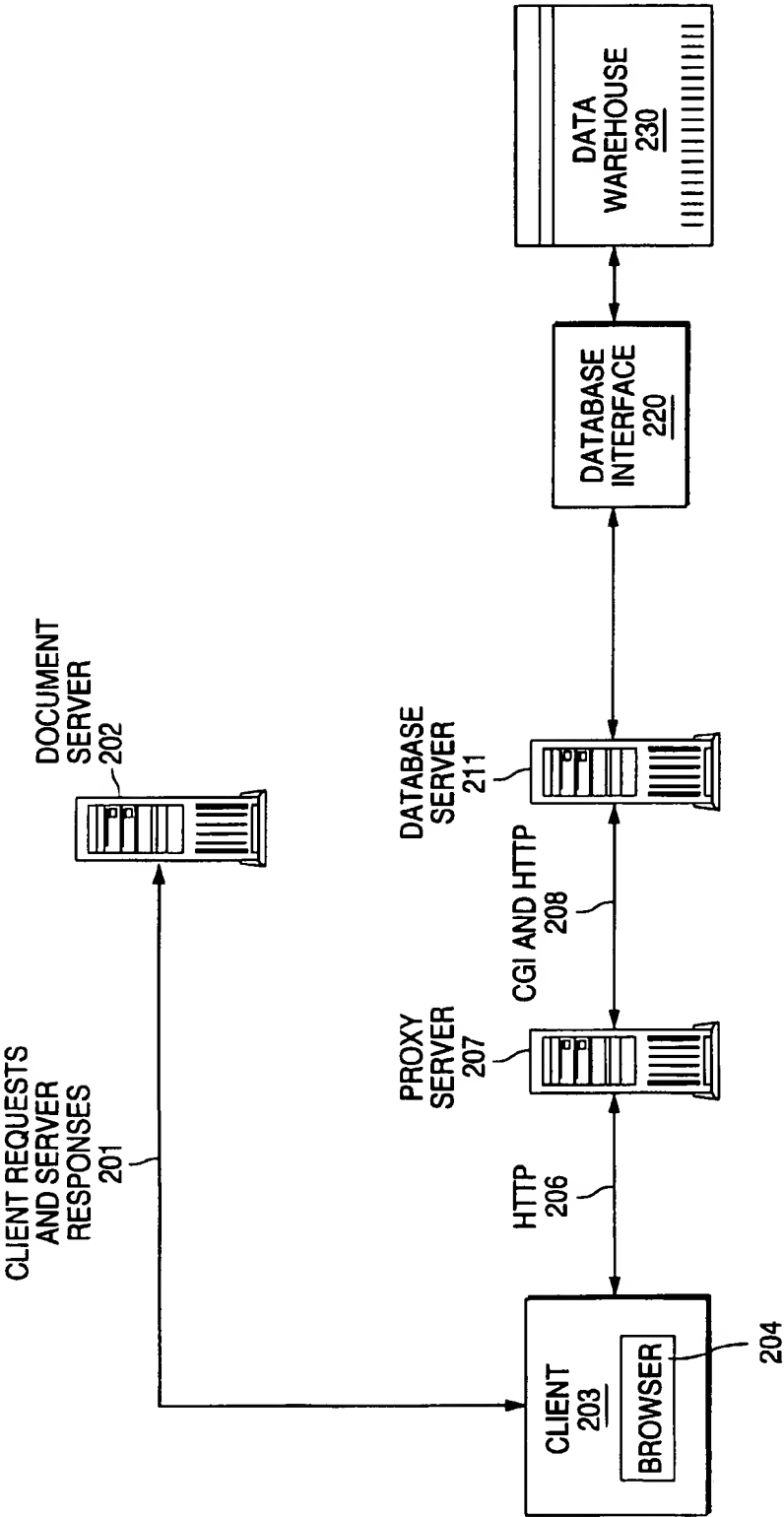
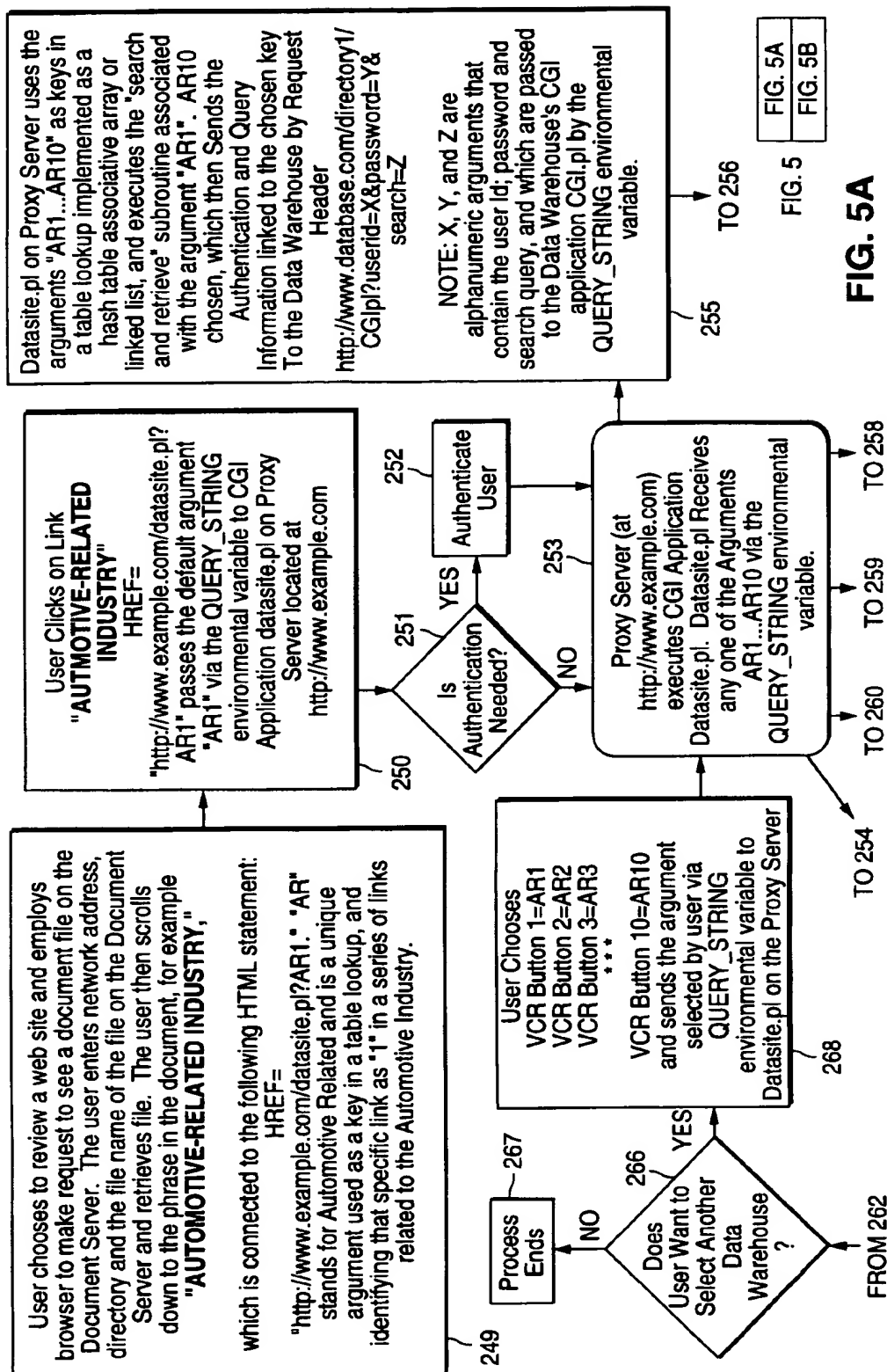


FIG. 4



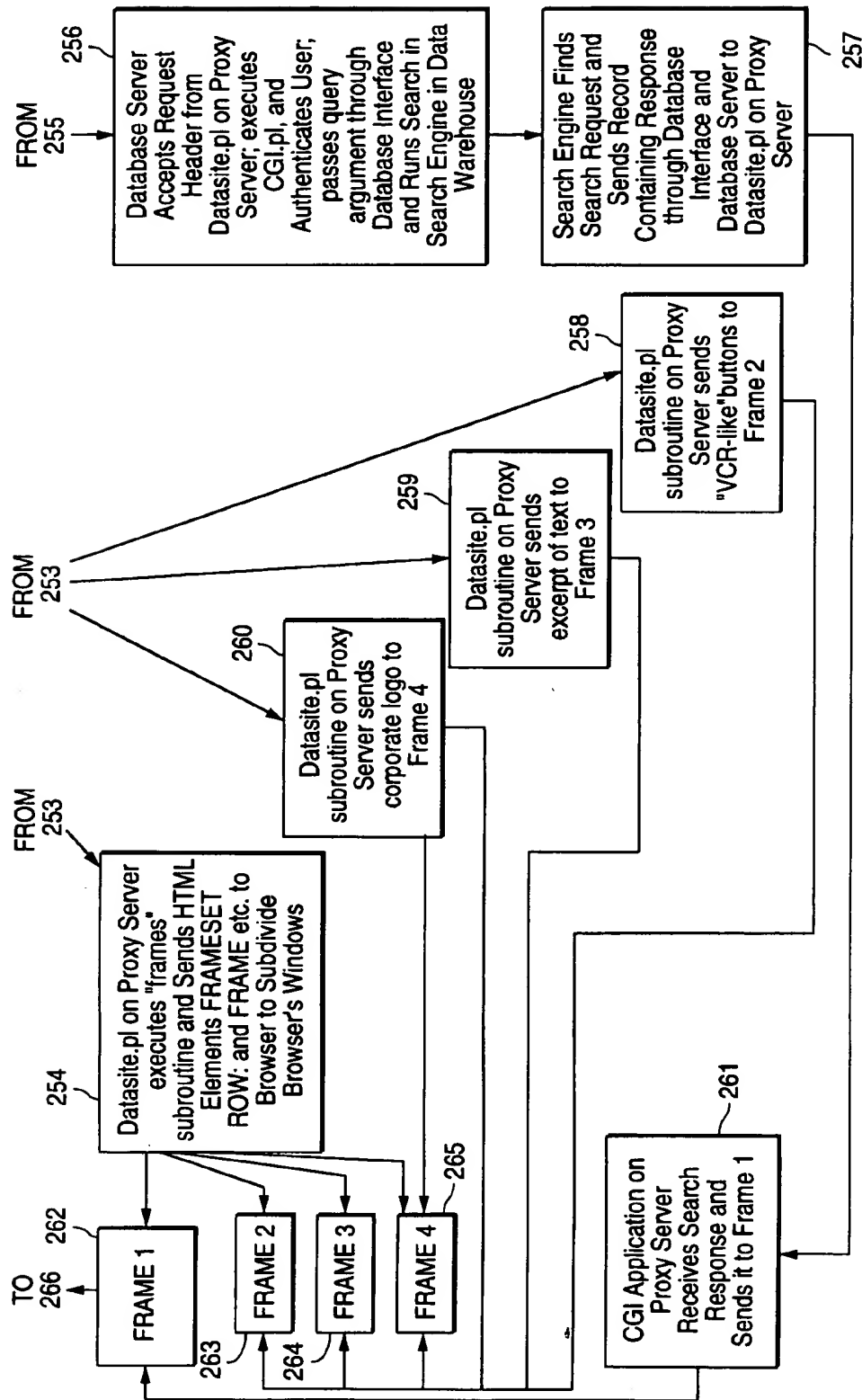


FIG. 5B

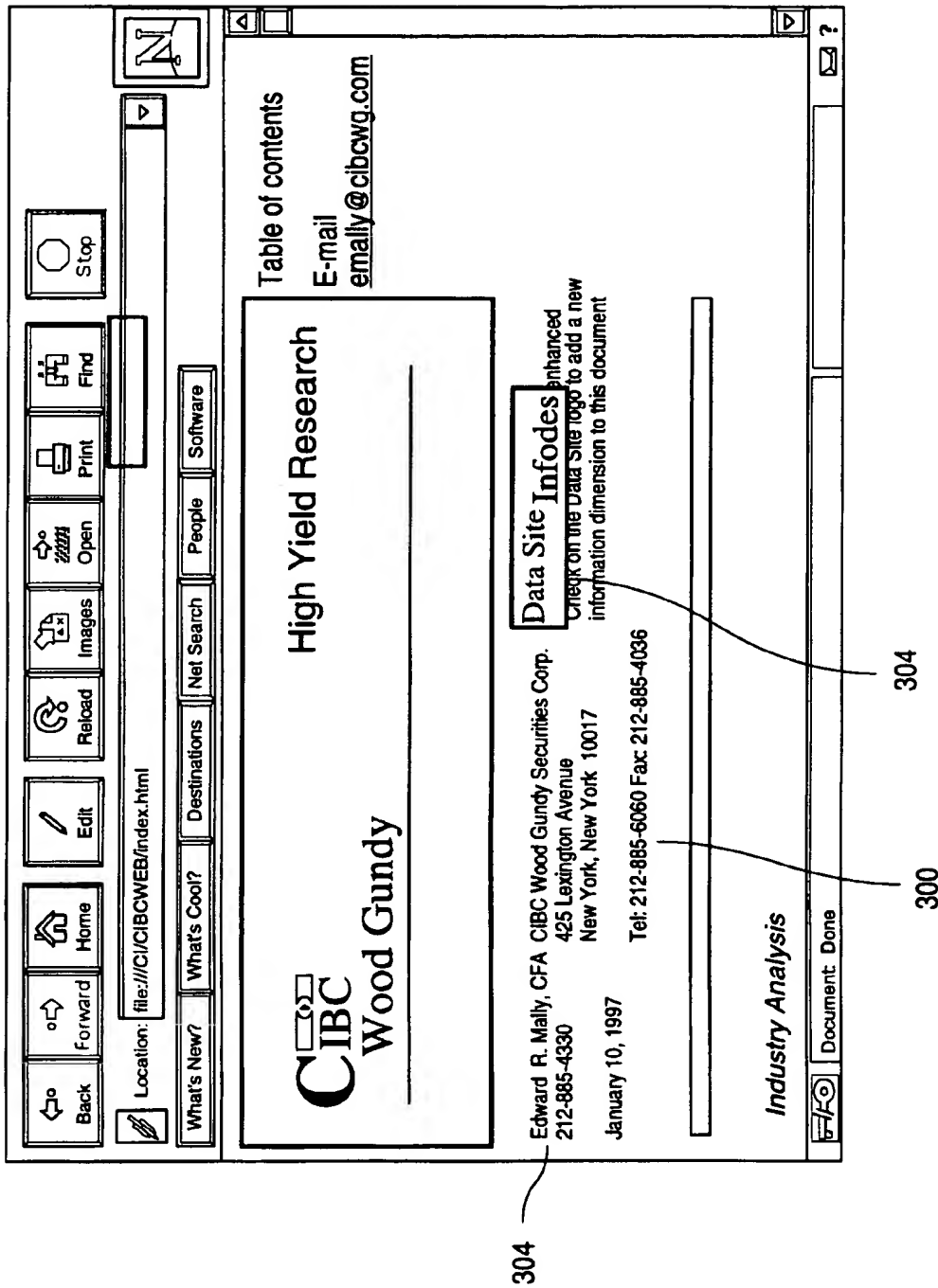


FIG. 6A

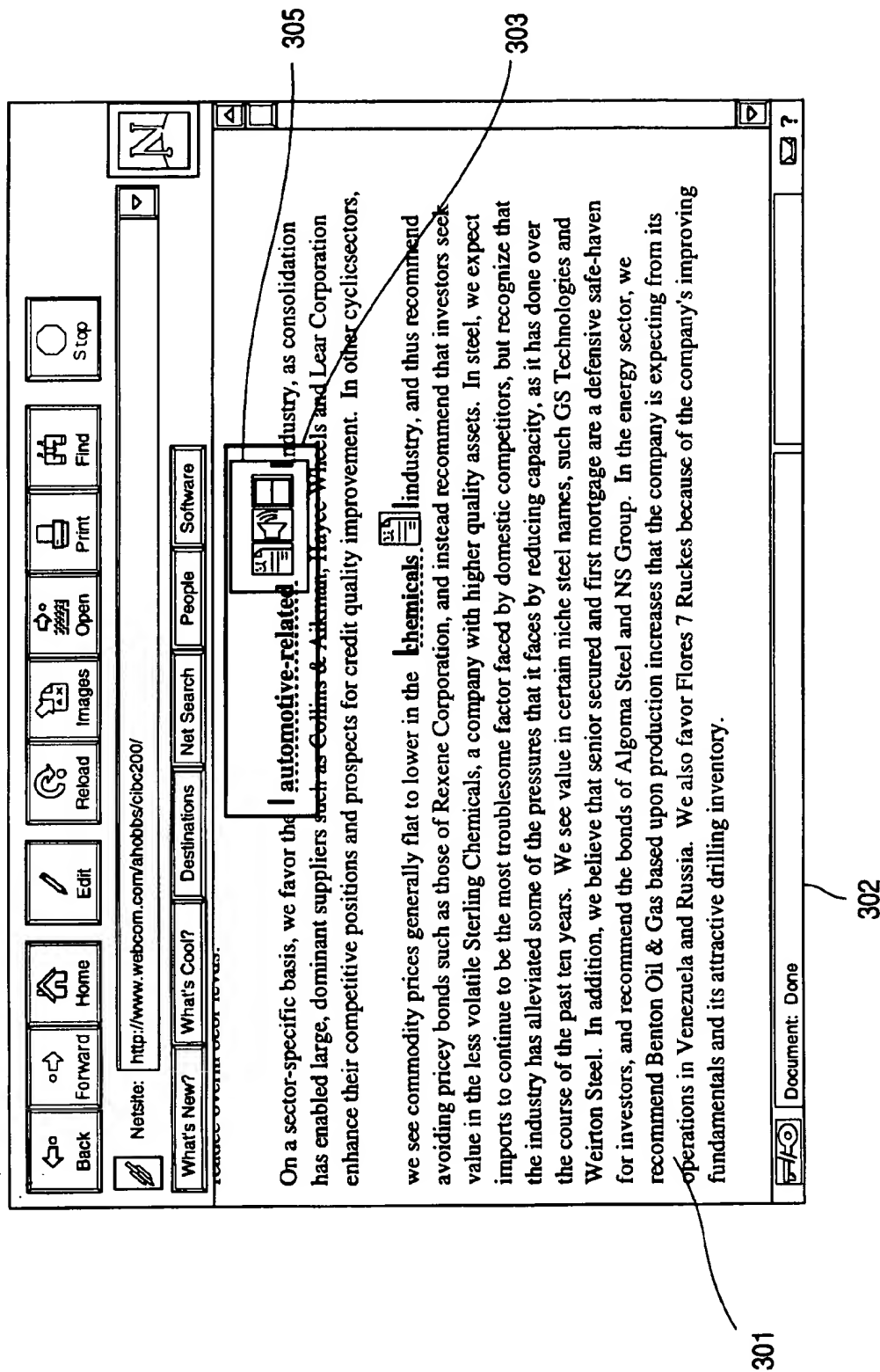


FIG. 6B

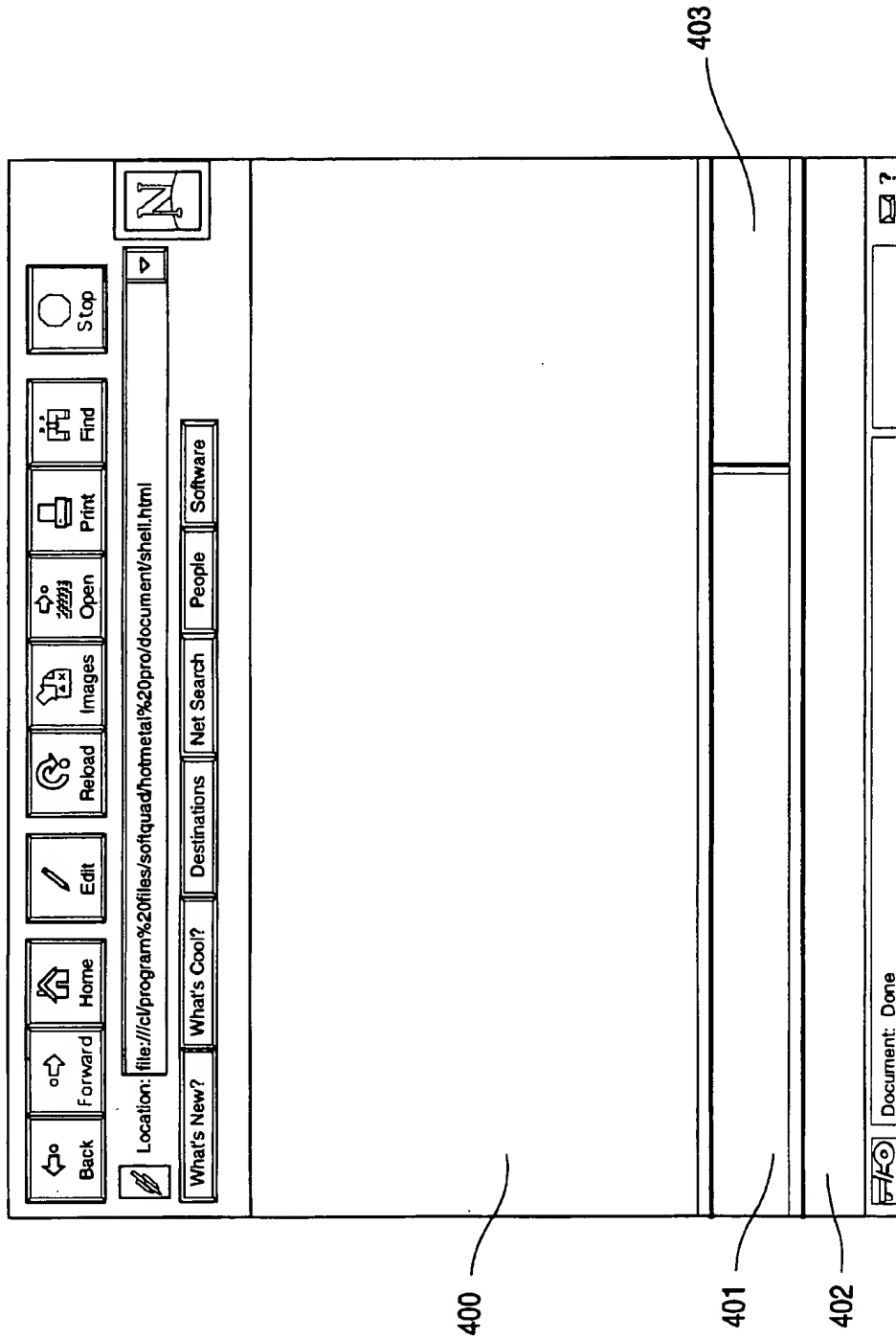
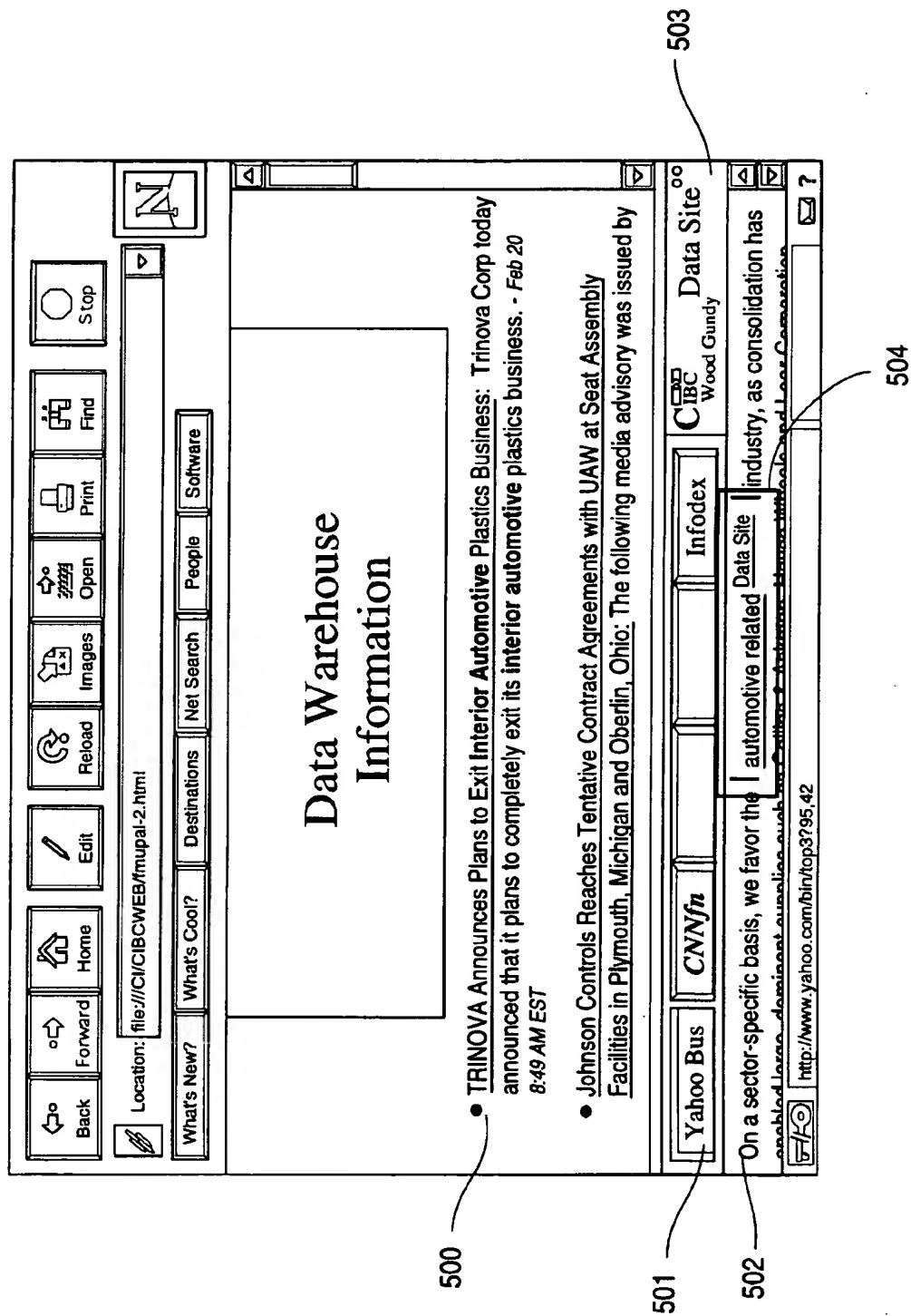


FIG. 7



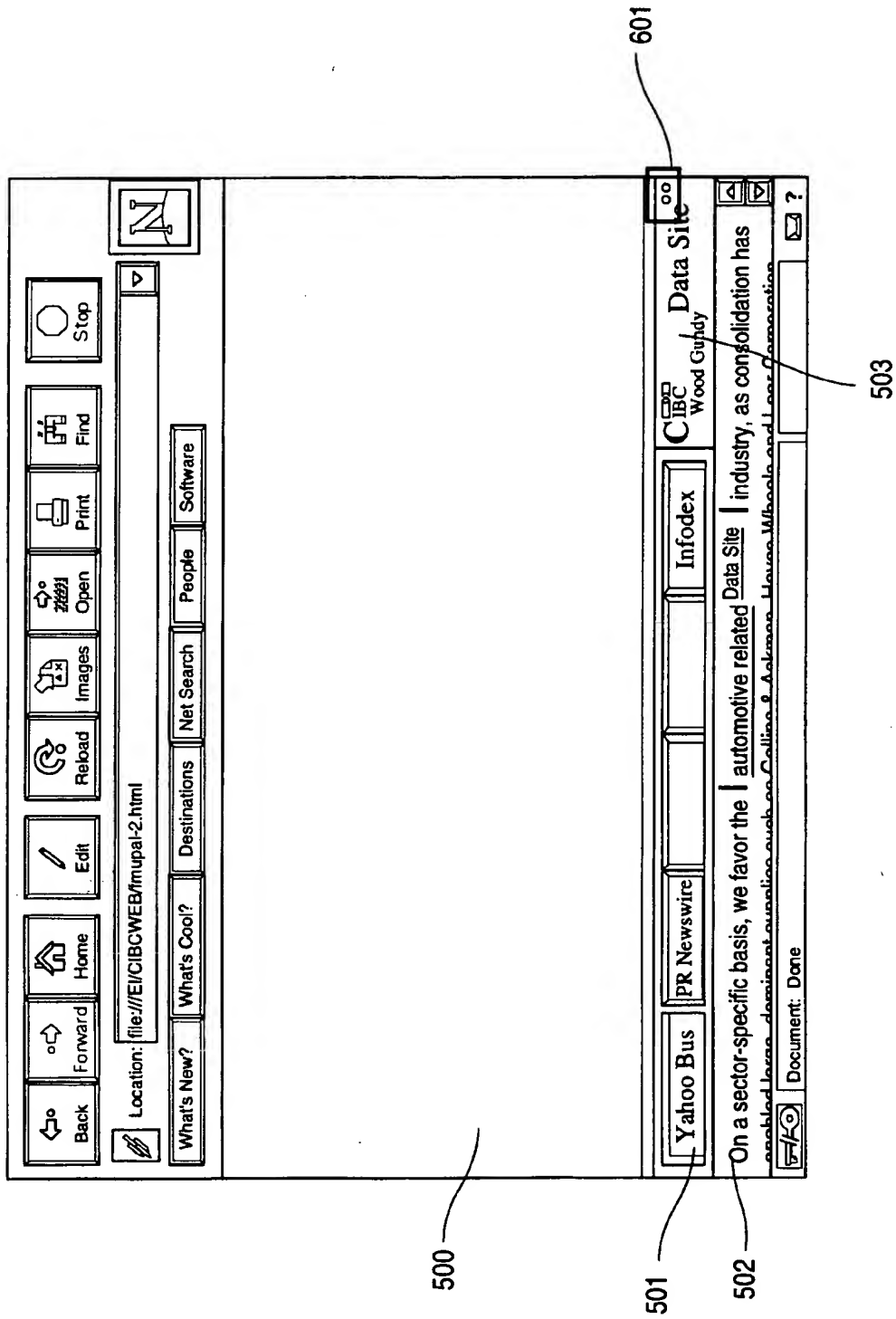


FIG. 9A

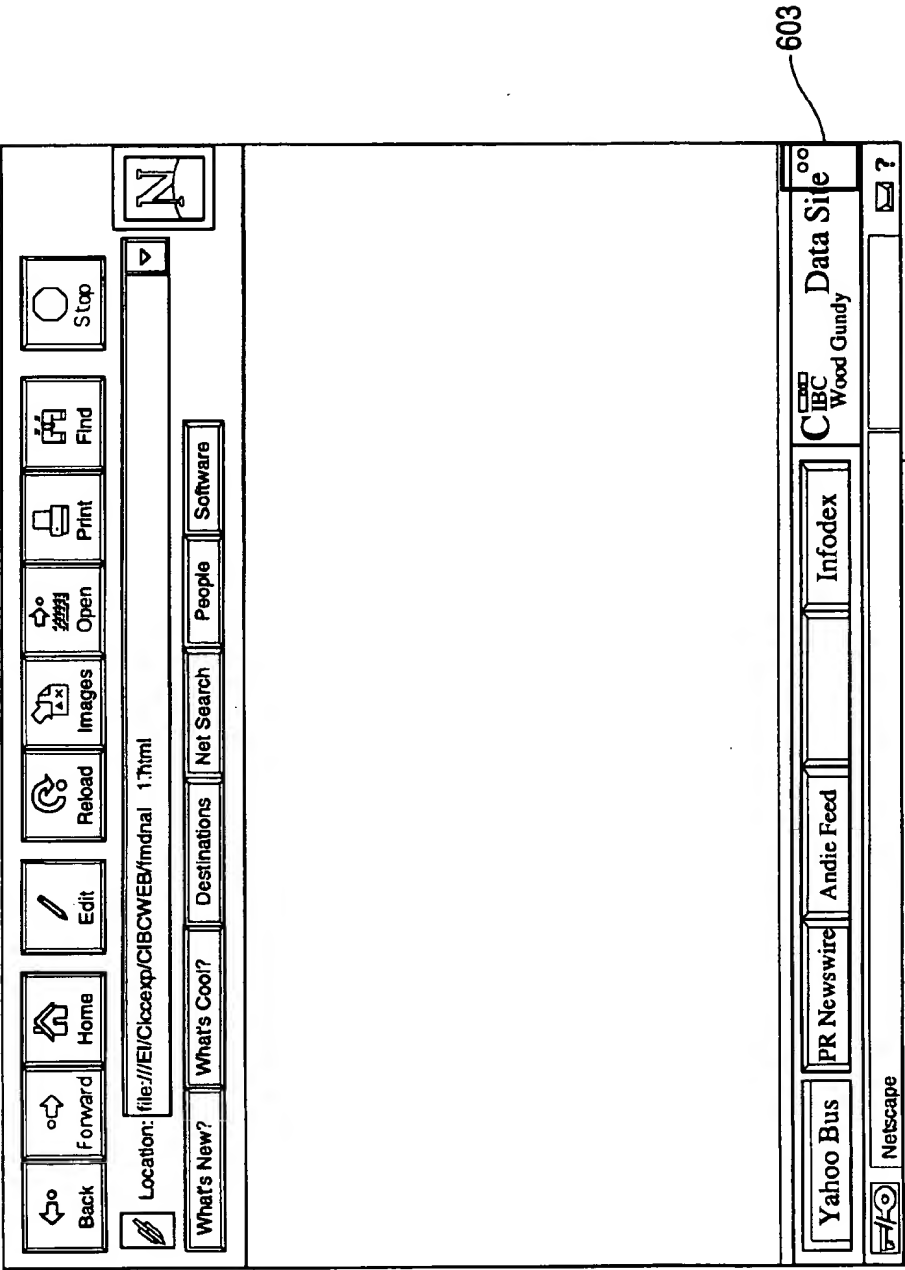


FIG. 9B

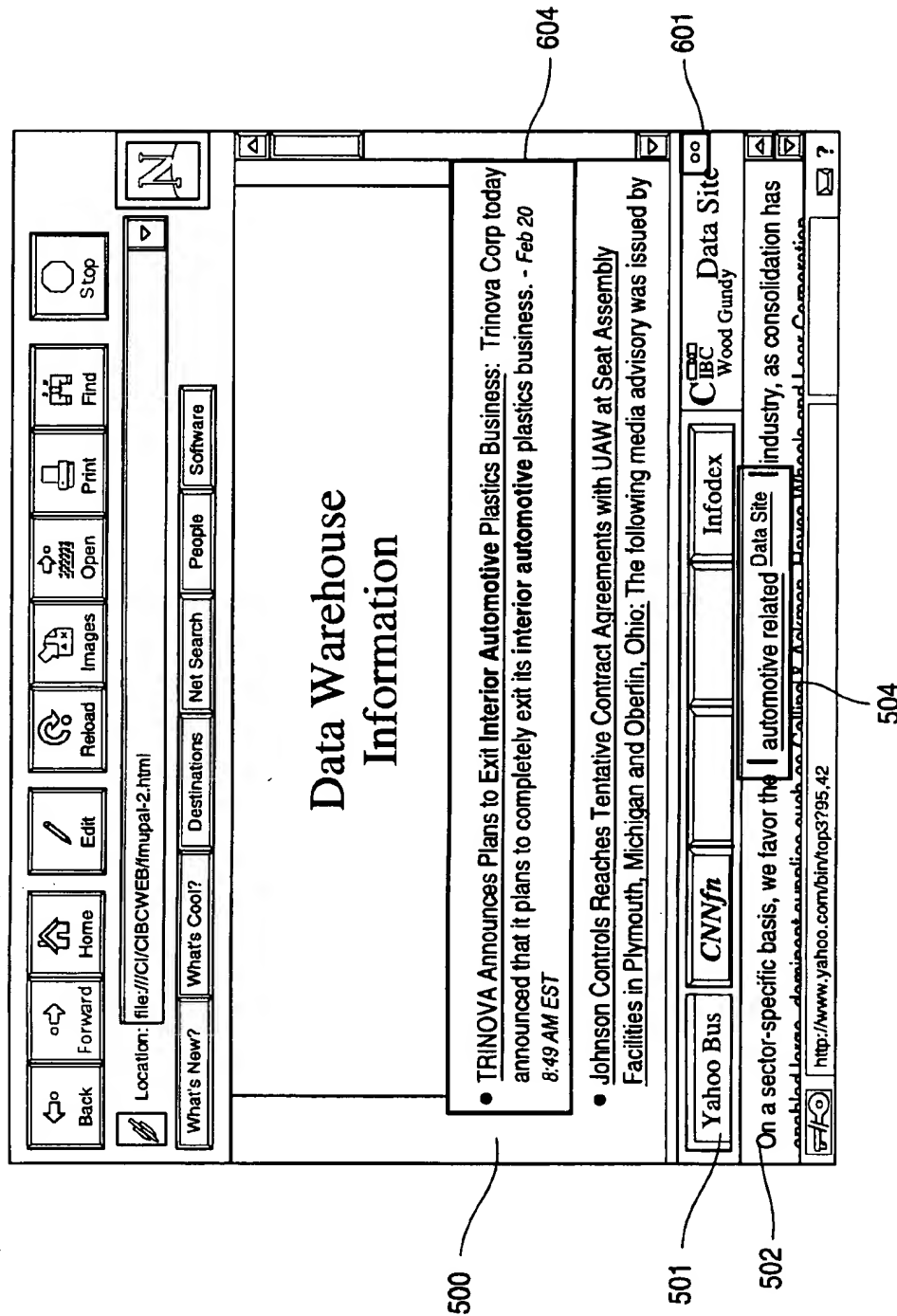
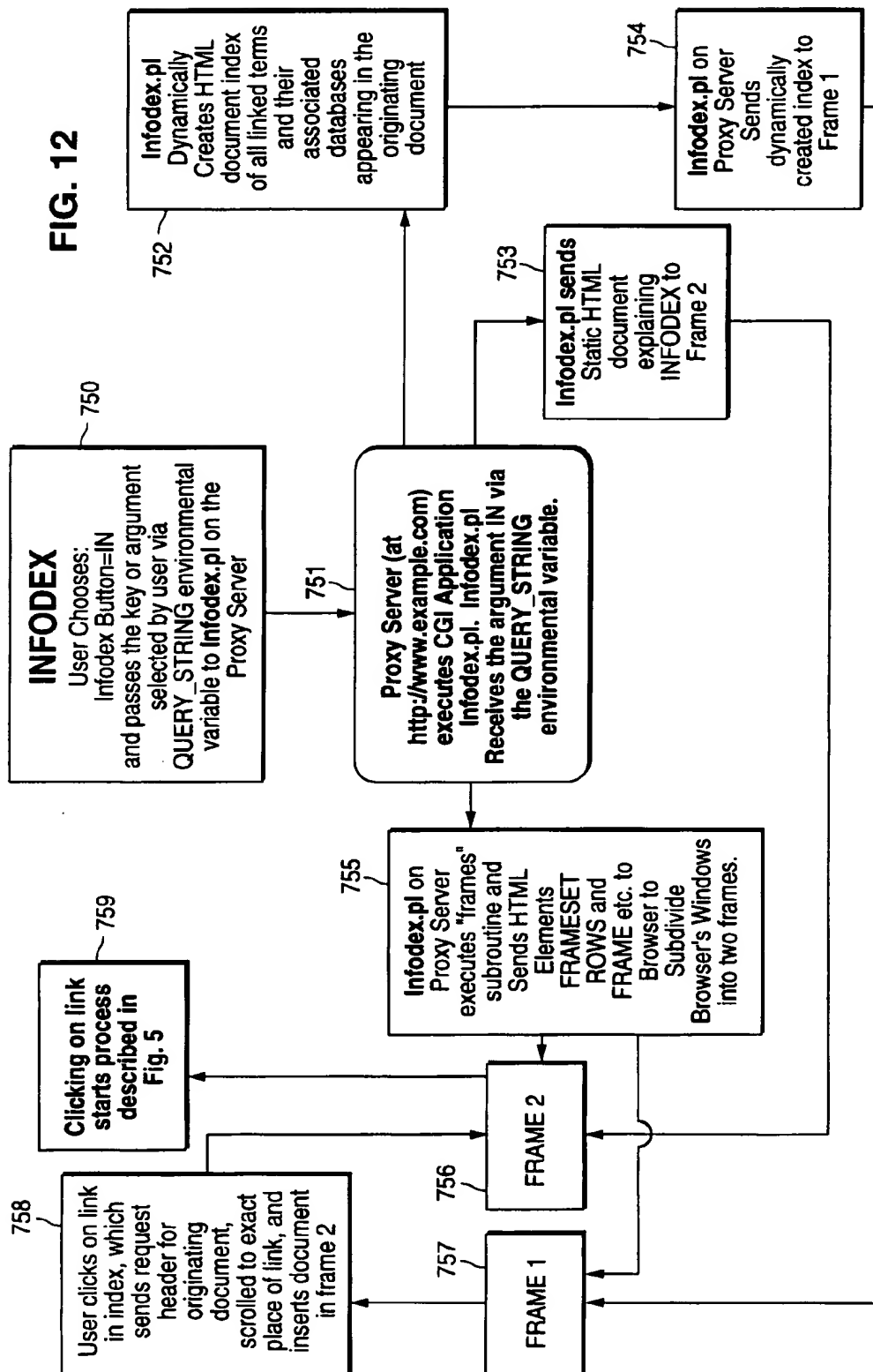


FIG. 10





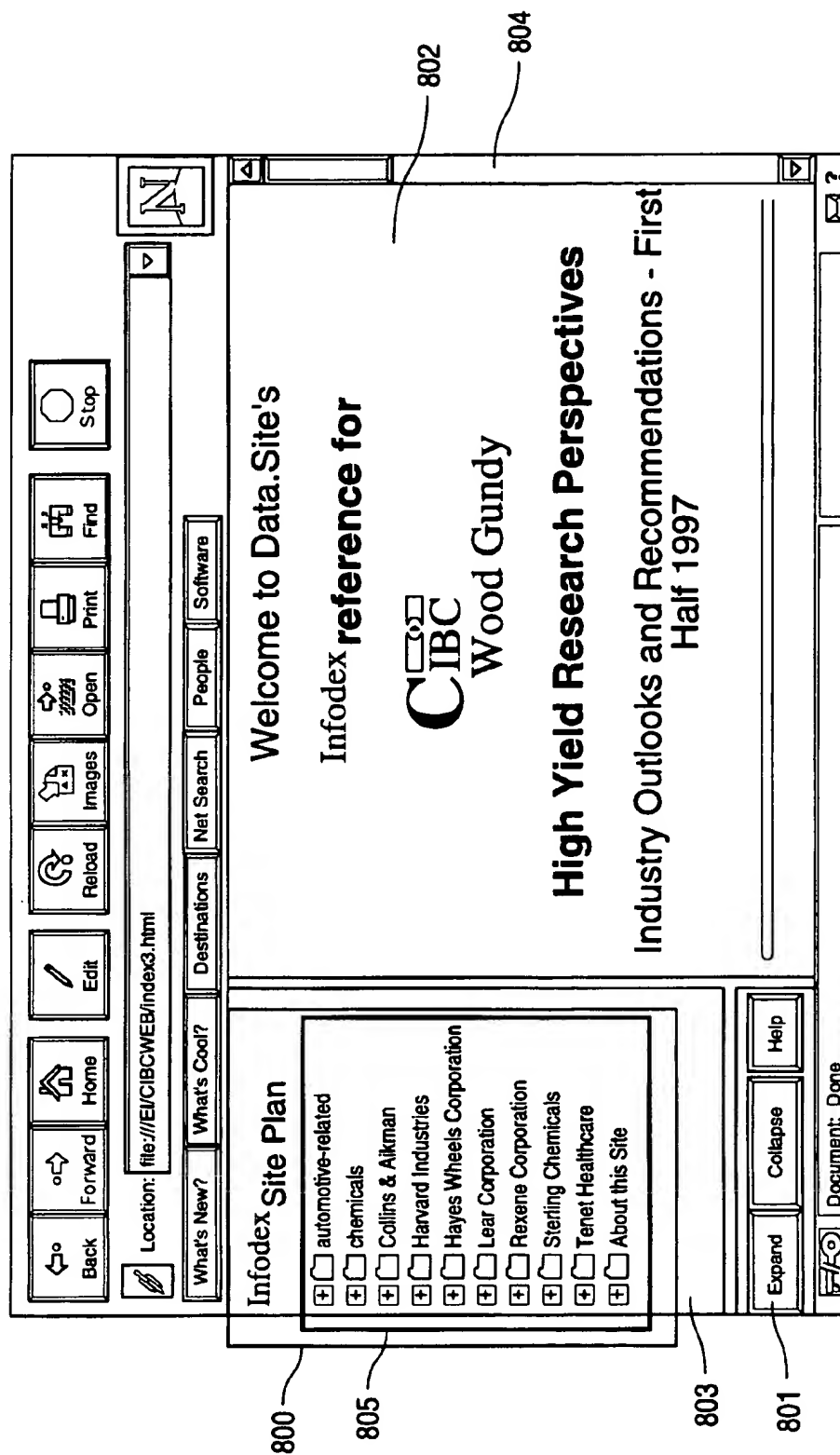


FIG. 13

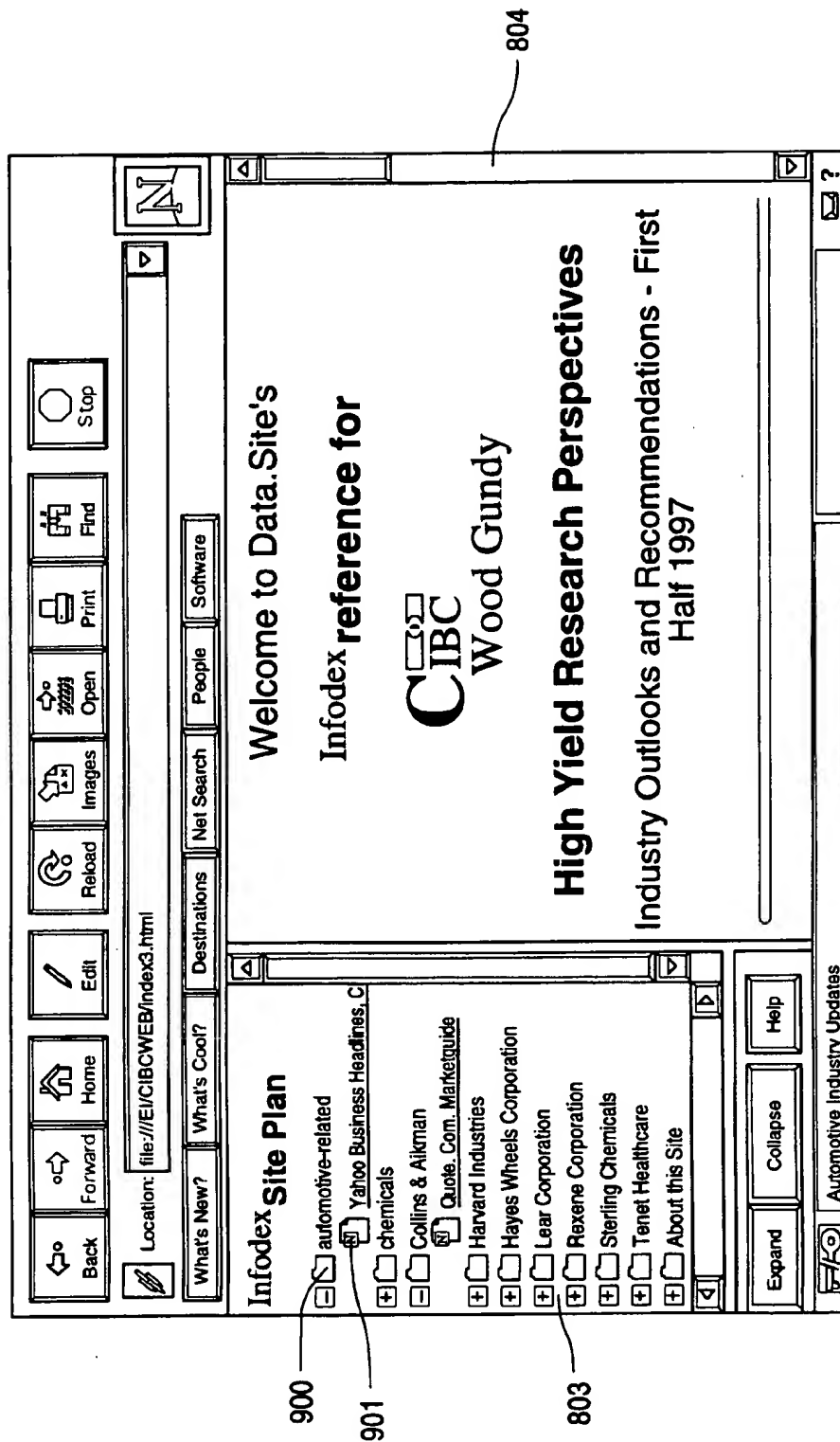


FIG. 14

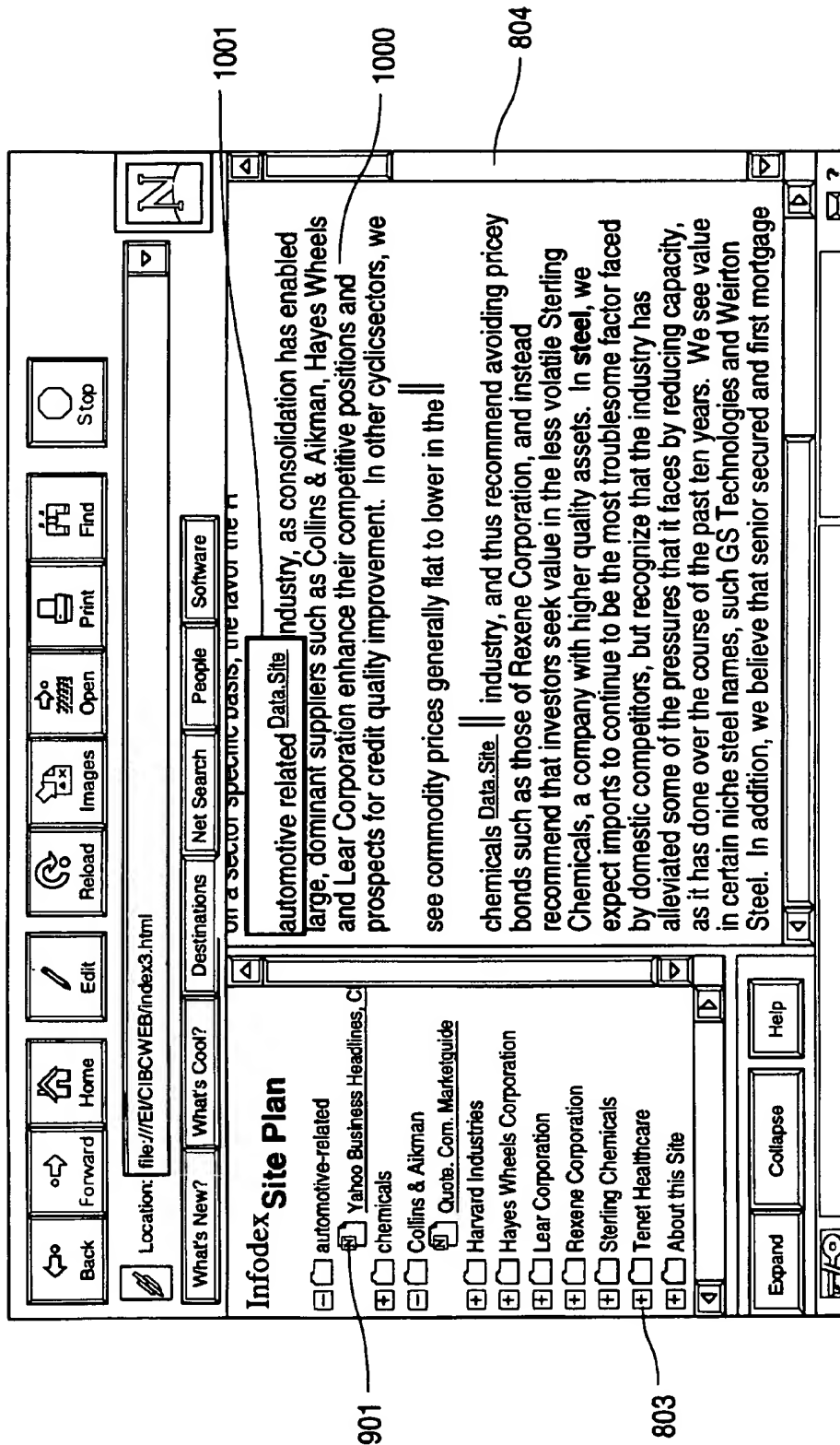


FIG. 15

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METHOD AND APPARATUS FOR SELECTIVELY AUGMENTING RETRIEVED TEXT, NUMBERS, MAPS, CHARTS, STILL PICTURES AND/OR GRAPHICS, MOVING PICTURES AND/OR GRAPHICS AND AUDIO INFORMATION FROM A NETWORK RESOURCE

BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention relates to information retrieval, and the application and deployment architecture for such information retrieval. Specifically, the present invention concerns a multi-tier client/server model for record retrieval wherein optimum record retrieval from a database is achieved based on embedded expert judgments linked to words, phrases, sentences and paragraphs of text; or numbers; or maps, charts, and tables (including spread sheet; or still pictures and/or graphics; or moving pictures and/or graphics; or audio elements (hereinafter sometimes collectively referred to as the "links" or "Linked Terms," or when any one of the aforementioned elements are used singly, as the "link" or "Linked Term"), contained in documents on a network resource, such as a web site and incorporating an intuitive graphical user interface (GUI) to correlate through a plurality of frames the retrieved records with records from one remote database or a large collection of remote databases maintained by one company, called a Data Warehouse, plus a means to select various databases or Data Warehouses and a comprehensive selectable index of the linked embedded expert judgments.

2. Background Information

"Pull" Technology

A conventional information retrieval system includes a database of records, a processor for executing searches on the records, and application software that controls how the retrieval system, such as a database management system (DBMS), accepts the search queries, manages the search, and handles the search results. Generally, the database includes records such as text documents, financial or court records, medical files, personnel records, graphical data, technical information, audio and video files or various combinations of such data. Typically, a user enters a password and client billing information, and then initiates the search by finding the appropriate database or groups of databases to search and formulating a proper query that is sent to the DBMS. This process is known as searching by pull technology. To effectively search and retrieve records from the database, the DBMS typically offers a limited variety of search operations, or query models, specifically designed to operate on the underlying records in the database. The query models are coordinated and executed by an application generally referred to as a search engine. For example, a document database, such as a database of court opinions, may be organized with each court opinion as a record with fields for the title of the case, jurisdiction, court and body text. A simple search engine may support a full text searching query model for all the text fields, individual field searching, such as searching by court or jurisdiction, and various Boolean search operations such as and, or, and not. More sophisticated search engines may support the following query models:

1. nested Boolean or natural language searches;
2. grammatical connectors that search for terms in a grammatical relationship such as within the same sentence or paragraph (e.g., "/s", "/p", etc.);

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3. proximity connectors that require search terms to appear within a specified number of terms of each other (e.g., "w/5");
4. exclusion terms ("BUT NOT");
5. weighted keyword terms;
6. wildcards;
7. specification of the order in which the database processes the search request (e.g., grouping words in parenthetical expressions);
8. restriction of the search to certain fields, and formulation of a restricted search such as by date, subject, jurisdiction, title, etc.; and
9. combination of the fields of search.

In addition, large commercial database providers, such as BLOOMBERG, DIALOG, LEXIS/NEXIS and WESTLAW typically have thousands of individual databases. These large commercial database providers are Data Warehouses, which comprise an architecture and process where data are extracted from external information providers, then formatted, aggregated, and integrated into a read only database that is optimized for decision making. Users subscribe to the Data Warehouses by monthly or yearly subscription, and then typically pay stratified levels of hourly charges for access to certain databases, or groups of databases.

Drawbacks of Pull Technology

One limitation of existing information retrieval systems, especially among the commercial Data Warehouses, is the burden on the user to first enter client and billing information and passwords to gain access and initiate the search, and then formulate the search query. Typically, the subscription based commercial database services provide password administration and extensive catalogues, both in print and on-line, describing the content and scope of the databases offered, and in some cases, live assistance by telephone by reference librarians who assist the user to find the proper databases. However, the user must remember the password, and spend time finding the proper database by catalogue, on-line access, or phone, or else incur more expensive hourly charges searching through single databases or groups of databases for the appropriate database content and scope.

A second limitation of pull technology is the formulation of the search query. To use the more powerful commercial Data Warehouses effectively, a user must be trained to use all of the aforementioned query models, and have sufficient knowledge of the topic to choose the appropriate keywords or natural language terms. The complexity of the search process compels the commercial Data Warehouses to offer training and keyword help to their subscribers by multiple publications that describe search tips; interactive software based training modules; account representatives who visit the user and train him or her; and customer service and reference librarians available by phone.

A third limitation of pull technology concerns how it is employed on the World Wide Web area of the Internet ("WWW") by such search engines as THE ELECTRIC LIBRARY, EXCITE!, FOUR ONE ONE (411), HOTBOT, INFOSEEK, LINKSTAR, LYCOS, MAGELLAN ALTA VISTA, OPEN TEXT INDEX, WEB CRAWLER, WWWWORM, and YAHOO!, just to name a few. These search engines' query models are beginning to approach the sophistication and complexity of those of the commercial database companies, but unlike the commercial databases, they offer minimal customer support. Another drawback of the Internet search engines, well documented in the computer business and popular press, is that their search engine algorithms cause multiple irrelevant responses to a query. Other drawbacks of Internet search engines employing pull technology include:

1. The great majority of the Internet search engines have no control over the records in their database. Unlike the commercial Data Warehouses who have an ongoing relationship with the content provider (usually by a license agreement), and who carefully screen, cleanse and format the information provided by their information providers, many Internet search engines sweep through the WWW periodically and automatically, and catalogue web sites as records in their databases. They also permit any web publisher to submit his or her web site as a record entry with little or no prior screening.
2. As a result of little or no screening, and absolutely no contact with the information provider, Internet search engines often provide search results that have multiple "dead ends," the result of links which are often moved or deleted after the search engines have catalogued them. Moreover, the web sites' authors can sometimes manipulate the words on their site and cause the Internet search engines to list their websites higher on the search engine's relevancy lists than other web sites.
3. The search engines' databases include only a fraction of the Internet's content, and even then, the content may be from dubious sources, or sources which are not updated frequently.
4. Where the web sites include embedded search terms in links in documents to existing Internet search engines or current awareness "news" databases, since the words are linked to the free Internet search engines discussed above, the information retrieved, for reasons explained above, is not reliable and users often receive multiple irrelevant responses. Words linked to the current awareness databases receive more useful information, but there is no GUI correlating and synchronizing the records of multiple databases. Typically, those web sites pass authentication information by the QUERY_STRING environment variable. Once placed on the command line by the browser, the viewer can see all passwords and usernames in the authentication argument.

The considerable logistical and practical drawbacks of pull technology are illustrated in the following example of an investment banker who is responsible for buying bonds for an institutional investor, such as a bank or an insurance company. This hypothetical investment banker, based on an actual person, will be used at different points throughout this patent application to illustrate and support the novelty and unobviousness of the present invention.

Every week, this investment banker must go before a board of executives at his bank and provide them with a list of bonds that he had examined and analyzed and recommends to the bank to buy. In order to do his due diligence he must cover in his report five areas of research concerning the bond: 1) compare the bond price to other bond prices (the Bond Comparables); 2) obtain historical data concerning the bond and the company issuing the bond (the Historical Data); 3) obtain the Securities and Exchange filings, such as 10K's, and 10Q's for the company issuing the bond (the SEC Filings); 4) obtain specific information from a wide variety of publications concerning the industry in which the company operates (the Industry Data); and 5) obtain information concerning the historical and anticipated performance of the company's stock (the Stock Data). Furthermore, he has to read various newsletters and white papers issued by investment banks desiring to sell the bonds to him, and which analyze the bonds using the same criteria mentioned above. In order to collect the data, this investment banker must log on and enter password and billing information; find the appropriate databases; and formulate

the search and obtain the results in three to five different Data Warehouses, each of which are organized differently from one another and have different methods to enter search queries, and different query models. While pull technology satisfies the demands for the breadth and depth of the search (since the user can formulate his or her own queries, and make unlimited selections of databases to search) it is time consuming, cumbersome and expensive because the user must find the appropriate query formulation and database or databases within which to run the query, sometimes even in different Data Warehouses.

"Push" Technology

In response to the flood of information facing the typical Internet user under the pull model, the complexity of the query statements, and the well documented inability of the Internet search engines to locate and deliver relevant content, software companies developed software agents to push information to users. The push model is also known as webcasting.

Under push, computers sift through large volumes of information, filtering, retrieving and then ranking in order of importance articles of current interest. The user fills out a "profile" (also called a "channer"), that defines a predefined area of interest or activates a filter. This, in turn, causes the webcast search engine to search its own databases, or the databases of others, for content matching the profile or the filters submitted by the user. The user, in order to access the channels and have the content "pushed" to him or her, must download special client software which acts either independently of, or in conjunction with, the user's browser. Alternatively, a user can access a dynamically generated web page on the webcaster's server that lists the found articles. (An example of a dynamically generated web page is "Newspage Direct" by Individual, Inc.)

One early version of the Internet push model, developed by Pointcast Inc., clogged the network behind a company's employees' firewall when large numbers of the company's software agents pulled information from Pointcast's servers on the Internet at or near the same time. Pointcast later alleviated this problem by providing remote servers that could operate behind a company's firewall and request and collect (or cache) information at once or at predetermined times from the Pointcast servers on the Internet. These intermediate servers then pushed the information to employees, which effectively centralized the distribution of information in the Information Services (IS) department.

As mentioned above, all push technology requires that users compile a "profile" to detail their interests. The prior art of delivering the information obtained by the search engine pursuant to the profile is divided into three broad categories: offline browsers; e-mail delivered content providers and information channels.

The offline browsers typically operate by requiring a user to complete a profile with predetermined categories; automatically search the Internet for the information specified in the profile and download the materials to the user's hard drive for viewing at a later time when the user is off the Internet. This first category of products include: Freeloader by Freeloader, Inc.; Smart Delivery by FirstFloor, Inc.; WebEx by Traveling Software, Inc.; WebRetriever by Folio Inc. and Web Whacker by ForeFront Group, Inc.

The second category of push products delivers the results of searches performed pursuant to the user's profile directly to the user's e-mail box, and includes: Netscape's Inbox Direct and Microsoft Mail.

The third category of push products arranges the predetermined categories into "channels" and uses filters to allow

users to customize their news deliveries from a broad range of proprietary news sources. It is claimed that the results of the searches are pushed or "broadcast" in real time to the viewer. Examples of this type of service include: BackWeb by BackWeb, Inc.; Headliner by Lanacom, Inc.; Incisa by Wayfarer, Inc.; Intermind by Intermind, Inc.; Pointcast by Pointcast, Inc.; and Marimba by Marimba, Inc. However, since the retrieved data is first cached on the service provider's server (e.g. Pointcast's server), and then again on the company's servers behind the firewall, the results of the search are not really "broadcast in real time."

There is a fourth category of push products which do not fall neatly into any of the above three categories of delivery. Citizen 1 by Citizen 1 Software, Inc., is a human organized hierarchical listing of free Internet search engines. The user can then select a number of databases which fall under that category, and run several simultaneous queries in the databases. Digital Bindery by Digital Bindery Company allows users to "subscribe" to web pages as they browse. Once a subscriber, the user will automatically receive via e-mail any updates to the web pages to which the user subscribed.

Webcasting attempts to eliminate the inefficiencies of pull technology, namely the time consuming and unproductive hunt for information through Internet search engines. Instead of an open ended search through many databases linked to the web by various search engines, as is done under the pull model, push substitutes one central secure database which has collected either the content itself, or the links to the content. However, in spite of the name, push, the information provider does not drive the distribution of data. Instead, a client (in a client/server arrangement) contacts the information provider and requests the information. The client then downloads the information in the background, giving the impression that it is broadcast, when in fact, it is only automatically downloaded at a predetermined time.

Shortcomings of "Push" Technology

"Push" may be a satisfactory method for serving information to knowledge workers who depend on a constant stream of updated factual information served in narrow categories. Examples of these kinds of workers would be sales representatives who must find new prospects, staff in field offices who must be aware of sudden price changes, information managers who must distribute software upgrades and marketing professionals who must be aware of the new products released by the competition.

However, there is a category of knowledge workers whose information needs are not properly satisfied by push technology. The hypothetical investment banker discussed above is an example of such a knowledge worker. These knowledge workers cannot use "filters" and "profiles" to provide the most relevant information since the information they need cannot easily fit into categories, but rather spans categories. These knowledge workers use information to solve problems that are rarely alike. They need information to solve a problem, but they do not know what they need day to day.

This knowledge worker culls information and sparks creativity by comparisons and contrasts, juxtapositions, and induction and deduction, rather than by looking at raw news reports. The investment banker discussed above, usually does not know well in advance what industry or company he will be analyzing. He also does not always know where his research and analyses will take him, or what databases he will use. His decisions are tied into so many variables that exist in the marketplace that his information cannot be predetermined by a general form or profile. A further limitation of webcasting is that it has not struck the optimum

balance between burdening the viewer with a persistent stream of alerts versus alerting the viewer when new information has arrived.

Moreover, since webcasting centralizes the development, control and the administration of "profiles" within an Information Services (IS) department, certain knowledge workers' information needs may not be satisfied by such centralization. IS departments, already strapped for resources to manage mail servers, web servers, Lotus Notes servers and application servers, may not be capable of managing servers that maintain lists of user "profiles" and dispatch software agents into the World Wide Web (WWW). The push model works only if IS departments proactively keep the profile lists current and advertise them internally. Furthermore, there may be enormous legal ramifications, as of yet not addressed, to companies downloading copyrighted material to their internal servers and redistributing it internally, especially if the push purveyor links to other websites or search engines without permission. See, "Legal Situation Is Confused on Web Content Protections," *New York Times*, Jun. 9, 1997, at page D5.

Finally, all the above examples of "push" technology, except for "Digital Binder," require the buying, installation, maintenance and updating of software by both the publisher and the user.

In addition to the above-mentioned disadvantages, both the push and pull models fail to address the need to efficiently, inexpensively, and frequently augment web sites with current or historical data. According to the Mar. 11, 1997 *Wall Street Journal*, in an article entitled *At Thousands of Web Sites, Time Stands Still*: "Nearly five million pages of a total 30 million indexed by AltaVista on the Web haven't been updated at all since early 1996 . . . Some 424,000 pages haven't been refreshed since early 1995—and 75,000 Web pages haven't been touched since before 1994."

Therefore, it is desirable to dynamically augment a static web page containing text, audio, graphics, and/or video information on a network resource with Linked Terms connected to current awareness and/or historical records from expert pre-selected Data Warehouses or single databases, thereby saving the enormous labor and time costs involved in updating web pages.

It is similarly desirable to permit users to choose and narrow their own search criteria through pull technology by clicking on Linked Terms in a written document, and still obtain the benefits of push technology by having current awareness and historical records pushed to update their selections without introducing new protocols or application programmers interfaces (API's) to operate. It is therefore desirable to provide a method and apparatus use of which does not encumber the user's or publisher's computer system in the following ways: 1) neither the user, nor the publisher has to buy, install, maintain or update software to use the invention; 2) use of the method and apparatus does not require large hard disk and memory allocations by the user; and 3) as a result of "2," use of the method and apparatus does not preclude using other push products simultaneously. This invention can work with any operating system that employs a browser, and can accommodate any binary data type, including FTP repositories, full Java applets and VRML, and any browser plug-in, such as Shockwave applications. Moreover, it can deliver information from a variety of sources, including from the Internet, company databases, groupware and intra- and extranets.

Finally, given the almost exclusive use of current awareness and historical data on databases for research purposes in the prior art, the present invention is unique and unob-

vious because it is the only invention that updates Linked Terms in any written document, including web pages, with current and/or archived information from databases and Data Warehouses using a proprietary user interface and embedded expert judgment. Updating web pages and written content in this matter effectively transforms raw information into data which can support any point made in any written document. So, for example, if the document is used for marketing purposes, this invention would permit raw information to be used for marketing purposes, etc.

It is also desirable to provide a method and apparatus, which, rather than seeking to identify records on a database whose characteristics exactly match what the user types into a query model, embody one or more kinds of expert judgment data for the purpose of selectively retrieving on demand the best fitting or most appropriate records in response to user data entry. Accordingly, it is desirable to provide a query architecture for an information retrieval method and apparatus that utilizes both pull and push technologies wherein knowledge workers can select their database resources based on the issue they must solve and current awareness or historical data can be pushed to them based upon embedded expert judgment based on the same issue once they have selected the database resources.

It is further desired that the Linked Terms in any document be augmentative and allow for the efficient integration of embedded expert judgment that correlates a user's choice of a Linked Term with optimum data information judgments or designations to identify those data where the fit between the user's choice of a Linked Term and optimum data for that Linked Term is best.

SUMMARY OF THE INVENTION

Broadly stated, the present invention encompasses a method of dynamically augmenting the contents of at least one file of information on a first network resource, said file of information having at least one link, said method comprising the steps of: creating at least one request corresponding to said at least one link; coupling at least one query argument with said at least one request; providing a database; sending said at least one request and said at least one query argument to said database; causing said database to search for at least one record that satisfies said at least one query argument; providing a display for viewing by a user; subdividing said display into a plurality of frames; displaying said at least one record that satisfies said at least one query argument in at least a first frame of said plurality of frames; and providing a series of graphic symbols in at least a second frame of said plurality of frames for enabling the user to select one of a plurality of databases.

In a preferred embodiment of the method of the present invention, at least one authentication argument is coupled to said at least one query argument and said at least one request. Furthermore, in a preferred embodiment, said at least one request, said at least one query argument and said at least one authentication argument are sent to said database. Also in a preferred embodiment, the method of the present invention further comprises subdividing the display into a second plurality of frames to replace said plurality of frames and providing a list of index terms in at least one frame of said second plurality of frames, where the index terms are for selecting said at least one link in said at least one file of information on said first network resource.

In a preferred embodiment, said at least one request comprises a request header specifying: a) a purpose of the request; b) a network address of a second network resource to which said request header is applied; c) a file name for an

application that is stored on said second network resource and d) an argument that acts as a key in a table lookup on said second network resource; and wherein an application that executes on a second network resource correlates in said table lookup said key with one of a plurality of expert predetermined optimum values, each said expert predetermined value comprising a network address for a database, a query argument, and an authentication argument. In a preferred embodiment, the key can be used to create a window display for viewing by a user, said window presenting the user with a menu of choices for further areas of research pertaining to said key. The user, by selecting one of said choices, causes said application that is executed on said second network resource to match a key, corresponding to said one of said choices in a table lookup, with a request header comprising: a) a purpose of the request; b) a network address for a third network resource to which said request header is applied; c) a file name for an application that is stored on said third network resource; d) a query argument; and e) an authentication argument; and causes said application on said second network resource to send said request header to said third network resource.

In another embodiment of the present invention, at least one embedded application is sent from the second network resource to the browser. The embedded application performs one or more of the functions previously performed by the application that is executed on the second network resource in the first embodiment of the present invention. The embedded application is preferably an applet.

The present invention also encompasses providing an apparatus for dynamically augmenting the contents of at least one file of information on a first network resource, said file of information having at least one link, said apparatus comprising: a browser having a display for viewing by a user; a second network resource coupled to said browser, wherein said browser sends at least one request corresponding to said at least one link to said second network resource, further wherein said second network resource couples at least one query argument with said at least one request, said second network resource further causing said browser to subdivide said display into a plurality of frames; and a database coupled to said second network resource, wherein said second network resource sends said at least one request and said at least one query argument to said database, said database comprising a search engine for searching for at least one record in said database that satisfies said at least one query argument; wherein said at least one record that satisfies said at least one query argument is displayed in at least a first frame of said plurality of frames and a series of graphic symbols are displayed in at least a second frame of said plurality of frames for enabling the user to select one of a plurality of databases.

In a preferred embodiment, the display is subdivided into a second plurality of frames to replace said plurality of frames and a list of index terms are displayed in at least one frame of said second plurality of frames, said index terms for selecting said at least one link in said at least one file of information on said first network resource. Also in a preferred embodiment, said second network resource couples at least one authentication argument to said at least one request and said at least one query argument, further wherein said second network resource sends said at least one request, said at least one query argument, and said at least one authentication argument to said database. Said second network resource preferably further comprises a memory, said memory storing a table look up having a plurality of expert predetermined optimum values, each said expert predeter-

mined optimum value having a network address for a database, a query argument, and an authentication argument, further wherein said at least one request comprises an argument that acts as a key in said table lookup, said key being correlated with one of said expert predetermined optimum values.

In another embodiment of the apparatus of the present invention, at least one embedded application is sent from the second network resource to the browser. The embedded application that is sent to the browser performs one or more of the functions that are performed by the application on the second network resource.

Accordingly, one object of the present invention is providing a method and apparatus to cost-effectively and dynamically update web pages containing text, audio, graphics, and/or video data that are a part of a network resource with Linked Terms connected to current awareness or historical records from expert pre-selected Data Warehouses or single databases, without undue waste of time and labor.

Another object of the present invention is to permit network users to have access to a large number of electronic database providers, such as BLOOMBERG, DIALOG, DOW JONES, LEXIS/NEXIS and WESTLAW, etc., without being limited to a particular proprietary graphical user interface (GUI), entering passwords or billing information or being trained to use the query models for each Data Warehouse.

Yet another object of the present invention is to permit wide spread dissemination of information from databases and Data Warehouses without the cost and security problems to the Data Warehouses of training users to use the system or issuing and administering a large number of passwords.

These and other objects and advantages of the invention will become evident to those skilled in the art in view of the following description of the invention.

BRIEF DESCRIPTION OF THE DRAWINGS

The present invention is illustrated by way of example and not limitation in the following figures in which like references indicate like elements and in which:

FIG. 1 is a block diagram of a typical digital computer utilized by a preferred embodiment of the present invention.

FIG. 2 illustrates a simple client/server system of the prior art.

FIG. 3 illustrates a more complex client/server system of the prior art.

FIG. 4 is a block diagram of one embodiment of the information retrieval system of the present invention.

FIG. 5 is a flowchart of a method of operating the information retrieval system of the present invention.

FIGS. 6, 7, 8, 9, 10 and 11 are examples of display screens presented to the user during the operation of the process outlined in FIG. 5.

FIG. 12 is a flowchart of the method of operating the "Infodex" indexing process of the present invention.

FIGS. 13, 14, and 15 are examples of display screens presented to the user during the operation of the process outlined in FIG. 12.

DETAILED DESCRIPTION OF THE INVENTION

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to which a claim of copyright protection is made. The owner has no objection to the facsimile reproduction by anyone of the patent disclosure, as it appears in the Patent and Trademark Office patent files or records, but otherwise reserves all copyrights and similar rights whatsoever.

The present invention overcomes the limitations of the prior art by providing an augmentative query architecture that allows the creation, addition and subsequent integration of embedded expert judgement and authentication information into a query submitted to an information retrieval system, together with an intuitive GUI designed to correlate through a plurality of frames the responses of the information retrieval system; a series of graphic symbols for enabling the user to select one of a plurality of databases or Data Warehouses and an index of terms for selecting a link in a file of information which is also referred to below as an information template or a file of data on a first network resource which is also referred to below as a server or Document Server. The invention comprises an information template which maybe a file of data in Hypertext Markup Language (HTML), or other mark up language embodying text, audio, graphics, and/or video elements, containing Linked Terms and posted in the preferred embodiment on a HyperText Transport Protocol (HTTP) server (the "Document Server"), which is connected to a network. The information template can be a document specifically prepared for publication on the World Wide Web (for example, a document in Adobe's Portable Document Format (PDF)); or a newsletter; white paper; or other document which has been printed, but converted into HTML.

The hypertext links in the information template contain the HTTP or other network protocol addresses to a second HTTP server on a computer network. The second server acts as a proxy server (the "Proxy Server") to both the client application and a third HTTP server on a computer network connected through a database interface to a Data Warehouse or database containing multimedia information searchable by the database's or Data Warehouse's proprietary search engine (the "Database Server"). When a user clicks on the hyperlinks appearing in the window of the browser, he or she will be in simultaneous interactive communication with both the Proxy Server and the Database Server across the network.

The Proxy Server runs a computer application that uses gateway protocols, such as the Common Gateway Interface ("CGI"). The application includes look-up tables that comprise authentication data for access to, and the network addresses of a plurality of Database Servers. The application will also contain in its look up tables queries (such as Boolean search terms, date and field restrictions and connectors) that have been formulated by expert judgment to return the optimum results from the Data Warehouse's proprietary search engine, and any other necessary information to authenticate a user, gain access to the Database Server, and run a search in the Data Warehouse's search engine. The CGI application on the Proxy Server will act as a bidirectional conduit between the Proxy Server and any application on the Database Server that can accept at runtime some form of HTTP data (for example, standard input (stdin) or environment variables such as QUERY_STRING). In another embodiment of the invention, the Proxy Server instead of using CGI can use embedded Structured Query Language (SQL) commands to pass the query argument directly to the Data Warehouse. In yet another embodiment, instead of using CGI or embedded SQL, one can use object oriented libraries such as Microsoft's Open Database Connections or Sun/Intersolv's

Java DataBase Connectivity-Object Database Connectivity (JDBC-ODBC) Bridge) to pass the authentication argument and the query argument.

When the user clicks on any one of the hyperlinks contained in the document on the Document Server, the CGI application on the Proxy Server will automatically return a set of framed windows, described in the HTML, to the browser, to which certain information will be targeted in the frames by the Proxy Server, or directly by the Database Server or by both the Proxy Server and the Database Server concurrently.

As a result of the browser's framed windows, and the client's simultaneous connection with the Document Server, Proxy Server and the Database Server, the user will be able to interactively access a range of expert pre-selected individual databases or databases in Data Warehouses linked to the Linked Terms appearing in the framed windows of the browser.

FIG. 1 is a block diagram of a typical prior art computer system 100 utilized by a preferred embodiment of the present invention. Computer system 100 may be a general purpose computer or a specially designed computer having features or capabilities equivalent to those described below in relation to computer system 100. Computer system 100 comprises an alphanumeric input device, such as a keyboard 120, coupled to a processing means, such as a Central Processing Unit (CPU) 140, such as an Intel Pentium chip. The input device may also be another computer, or other known input devices. An additional user input device 110 for communicating cursor direction or selection, such as a mouse, trackball, stylus, motion pad, or cursor direction keys may be coupled to CPU 140. CPU 140 is coupled to Read Only Memory (ROM) 142 and main memory 141, which in a preferred embodiment comprises Random Access Memory (RAM). Additionally, input/output device controller 170 and a bus 150 are coupled to CPU 140.

Main memory, which may include RAM or some other volatile storage device, is for storing information and instructions to be executed by the CPU 140. Main memory 141 may also be used to store temporary variables or other intermediate information during execution of instructions by CPU 140. ROM 142, which may be replaced by or used in conjunction with some static storage device, is coupled to CPU 140 for storing static information and instructions during processing by CPU 140. Computer system 100 also comprises hard disk 164, which is a data storage device that communicates with CPU 140 across bus 150. Computer readable removable media 172, such as magnetic or optical disk (including but not limited to magnetic tapes, laser disks, or CD-ROMs or DVDS), may be coupled to an input/output device 171. Data is read from or written to the removable media by the I/O device under the control of the I/O device controller 170. These media may be used for storage of the various files to be described herein including graphic and text files.

Computer system 100 may also comprise an output device 130, such as a cathode ray tube (CRT) or liquid crystal display (LCD), coupled to the CPU 140 for displaying information to a computer user. In addition, an audio output device 180 which converts digital information to analog information and delivers the output through headphones, speakers, or other well known audio mixing and storage devices such as magnetic tape may be coupled to the bus 150 through the audio adapter 161. Other devices such as graphic (or video) output devices 181 may also be coupled to the bus 150 via a graphics adapter (or a video accelerator adapter)

162, which also can send graphic or video output to output device 130. Network connection or modem 163, or some other output device may also communicate with CPU 140 across bus 150. Network connection or modem 163 may communicate with other networks, such as the Internet, extranets, intranets or data processing systems 183 across communication line 182.

It is to be noted that the following discussion of various embodiments discussed herein will refer specifically to a series of routines which are generated in a high-level programming language (e.g., the PERL interpretive language) which is interpreted and/or executed in computer system 100 at run-time. These further are used in conjunction with the browser and server software available from Netscape, Microsoft and other producers of graphical browsers that communicate through network protocols such as HTTP, as described above. It is also to be noted, however, that the following methods and apparatus may be implemented in special purpose hardware devices, such as discrete logic devices, large scale integrated circuits (LSI's), application-specific integrated circuits (ASIC's), or other specialized hardware, or implemented by combinations of the computer components with other non-computer components, such as Microsoft's Web-TV, or reduced capacity computers, such as Sun Microsystems, Inc.'s ("Sun Microsystem's") Network computer, which can consist of a web browser, a network connection, 4 MB to 8 MB of memory and a display screen. The description here has equal application to apparatus or programming languages having similar function.

FIG. 2 illustrates a simple client/server system of the prior art in which a single, bidirectional communication line establishes a connection between a client and server across a network. The client is an application program that establishes connections over a network for the purpose of sending requests and receiving responses. The server is an application program that accepts connections in order to respond to requests sent by the client. A connection is a transport-layer virtual circuit established between two application programs for the purpose of communication.

In FIG. 2, client 200 is coupled, by a bi-directional connection 201 to server 202 (typically, a remote computer system accessible over the Internet or other network) which can parse an Internet protocol, such as Hypertext Transfer Protocol (HTTP). Client 200 sends requests for information to server 202 by bi-directional connection 201. Server 202 searches for the requested data in its files, finds and retrieves it, and then presents the data as server responses to the client 200 via bi-directional connection 201. As server 202, in a preferred embodiment, operates in an HTTP protocol, it is also referred to as an HTTP document server. HTTP is a communications protocol that supports distributed collaborative information systems over the Transmission Control Protocol/Internet Protocol (TCP/IP) packet based routing system used by the Internet, including TCP/IP version 6.0. It is to be noted that other transport layer application programming interfaces (API's) such as the Component Object Model (COM); Distributed COM (DCOM); IBM's System Object Model (SOM) and Distributed SOM (DSOM) for networks and Java; Microsoft's ActiveX; Common Object Request Broker Architecture (CORBRA) (with enhancements) and Sun Microsystem's Java's Remote Method Invocation (RMI) for the Internet may also be used in the present invention.

HTTP has an open-ended set of methods that can be used to indicate the purpose and location of a request. These methods signal the purpose of a request by using terms such as Simple Mail Transport Protocol (SMTP); File Transport

Protocol (FTP); or HyperText Transport Protocol (HTTP). Other methods can use the Uniform Resource Identifier (URI); Uniform Resource Locator (URL); or Uniform Resource Name (URN) to indicate the network resource to which a method is to be applied. A network resource is a network data object or service that can be identified by a URI, URL or URN. An example of a URL is: `http://www.example.com/file.html`, which provides the address of subdirectory "file.html" on the network resource "www.example.com". A network resource may also be a server, a database or Data Warehouse.

HTTP can also be used as a generic protocol for communicating with other Internet protocols such as SMTP, Network News Transport Protocol (NNTP), FTP, Gopher or Wide-Area Information Services (WAIS). An HTTP message consists of a structured sequence of octets (a set of eight bits) transmitted by the connection.

FIG. 3 illustrates a more complex client/server system of the prior art. The system shown in FIG. 3 will be used to illustrate the flow of information in a typical academic and research oriented on-line service, such as LEXIS-NEXIS. In the case of LEXIS/NEXIS, remote users would pay a yearly subscription fee plus stratified hourly charges to access the Data Warehouse run by this on-line service. To access LEXIS/NEXIS, a user dials in from a remote PC using client 200, which includes LEXIS' proprietary software, and sends requests via the service's closed-access network 205. Multiple front-end communication servers 210, which can handle more than 3,000 simultaneous sessions during peak business hours and that run and use proprietary applications and standard and non-standard transport protocols, would feed the queries through a database interface 220 to five large multiple virtual systems (MVS)-based operating system servers, which are collectively designated as Data Warehouse 230. LEXIS/NEXIS supplements their MVS systems with 120 UNIX-based servers to manage data. All other on-line services such as DIALOG, WESTLAW and BLOOMBERG have similar setups. LEMS/NEXIS is an example of a Data Warehouse, as that term is used herein.

During 1996, all of the on-line services, including the academic and research oriented ones, migrated in varying degrees to the Internet and the World Wide Web (WWW) or simply the "Web". It is anticipated that, in order to provide access to the WWW via the Internet transport protocol HTTP, the major research and academic databases, as well as all new database on-line services, will have to integrate HTTP servers into their front-end communications servers, and convert parts of their data stores into HTML, or use interfaces to convert documents into HTML on the fly. Corporate intranets are also switching to the HTTP protocol and will integrate some form of HTTP servers or HTML conversion "on the fly" to access their legacy databases.

By adhering to the HTTP protocol, a standard is developed that reduces and simplifies the variety of interfaces and gateways used by the on-line services and Data Warehouses to provide widespread access to their data stores. This, in turn, makes it possible to interpose an HTTP server as a proxy server between the client and the database without additional complicated gateways or interfaces. As used herein, a gateway is any application program that receives data from a browser or other HTTP server and converts it into a form the database can understand. An interface is a software application that interacts with a database or Data Warehouse.

FIG. 4 is a block diagram of one embodiment of the information retrieval system of the present invention. The

informational retrieval system, shown in FIG. 4, comprises client 203 which is coupled to Document Server 202 and Proxy Server 207. Active within the client 203 is a first process, known as a browser 204, which establishes the connection, via the HTTP protocol with remote servers. A browser is an application which runs on a client and which can access a variety of servers providing information, including HTTP servers. Client 203 is coupled to Document Server 202 by bi-directional connection 201 through which client 203 sends requests for information (client requests) to and receives information from document server 202 as described in relation to the system shown in FIG. 2. Client 203 is coupled to Proxy Server 207 by HTTP connection 206. Client 203 and Proxy Server 207 interactively communicate with each other using the functionality provided by HTTP. The WWW includes all the servers adhering to this standard which are accessible to clients via TCP/IP addressing methods, such as the URL's. For example, communication can be provided over an HTTP protocol used on a TCP/IP network. The client application and server may be coupled via Point to Point (PPP), or Serial Line Internet Protocol (SLIP) for dial up connectivity to the Internet, or by 56 Kbps, ISDN, Frame Relay, T-1, T-2, T-3 or T-4 for high speed connectivity to the Internet.

Proxy Server 207 is coupled to Database Server 211 by connection 208. Proxy Server 207 and Database Server 211 interactively communicate with each other using the functionality provided on connection 208 by the Common Gateway Interface (CGI) and HTTP via connection 208. The Document Server 202, Proxy Server 207 and Database Server 211 are typical HTTP servers equipped with varying degrees of memory and hard drive space. At a minimum, an example of a typical installation of each server would consist of a Sun Microsystems Netra workstation running a Solaris 2.5 operating system and employing 32-64 megabytes of memory and 2 gigabytes of hard drive space. The workstation can use the National Center for Supercomputing Applications (NCSA) HTTP daemon or some other comparable software such as Netscape's Enterprise Server as the server software.

Database Server 211 is in turn coupled to Data Warehouse 230 via Database Interface 220. Data Warehouse 230 may include one or more databases. Database Server 211 acts as a front-end communications server to data stored in Data Warehouse 230 or an individual database.

Applications stored and executed on Proxy Server 207 can use a Common Gateway Interface (CGI) protocol interface; a CGI protocol interface with vendor added extensions such as Oracle's Web Request Broker; a non-CGI programmatic object oriented communications protocols interface, such as Java Servlet application programmer's interface (API), Java applets; or non-CGI programmatic server extensions, such as Microsoft's Internet Server API, or Netscape API, as a gateway interface to Data Warehouse 230 or an individual database. It is to be noted that, according to the present invention, one of the aforementioned applications on the Proxy Server, among other things: 1) correlates in a table lookup, a key sent by the browser 204 on client 203 to Proxy Server 207 with one of a plurality of expert predetermined values (each expert predetermined value comprising a network address for a database or Data Warehouse, a query argument, and an authentication argument); and 2) generates a second request header where the request header comprises a purpose of the request, a network address for a third network resource to which the request header is applied, a file name for an application that is stored and executed on the third network resource, an authentication argument and

a query argument), and, if required, modifies a record that satisfies the query argument. Therefore, the application on the Proxy Server effectively couples a query argument to a request sent by browser 204 on client 203 to Proxy Server 207. Additionally, the application preferably couples at least one authentication argument to the query argument and the request. Additionally, the applications on the Proxy Server 207 preferably cause browser 204 to subdivide its display into a plurality of frames, cause a record that satisfies the query argument to appear in the largest of the frames, cause a series of graphic symbols, e.g., buttons, to appear in a second frame for enabling a user to manually select one of a plurality of databases or Data Warehouses; cause an excerpt of text that includes a link in a file of information to appear in a third frame; and cause information associated with the source of the file of information to appear in a fourth frame. When the user manually selects one of a plurality of databases or Data Warehouses, the application correlates in a table lookup a key, sent by the browser 204 when the user manually selected the database or Data Warehouse, with one of a plurality of expert predetermined values, and sends a third request header to the third network resource, such as Database Server 211. Thus, the applications both send a request header in response to the selection of the link or a button and match a key corresponding to the link or button with a request header. Similarly, the applications send the request, the query argument and the authentication argument to the Database Server 211.

FIG. 5 is a flowchart of the method of operating the information retrieval system of the present invention. At step 249 of the process, the user, employing a browser 204 running on a client 203 (shown in FIG. 4), sends a request via a network protocol such as HTTP for an HTML file to the Document Server 202 (shown in FIG. 4). A typical HTTP statement is in the form `http://www.example.com/file.html`. The HTML file "file.html" may be an HTML document that will have words, phrases, sentences and paragraphs, or graphics, video and audio elements, each symbolized by an argument abbreviating the name of the term or client (the "Argument Symbol"). The HTML document may be a document prepared for publication on the WWW (including a Web page), a newsletter, or a white paper or other document which has been printed but converted into HTML. In the example shown in FIG. 5, the Linked Term is the phrase "AUTOMOTIVE-RELATED INDUSTRY," and the initial default Argument Symbol that is assigned to it is "AR1". An HTTP network address in the form of `http://www.example.com/datasite.pl` is employed, where "http" is the purpose of the request, "www.example.com" is the address of the Proxy Server and "datasite.pl" is the name of a CGI application on the Proxy Server 207 (shown in FIG. 4). The Argument Symbol is added to the end of the HTTP network address after a question mark as shown in FIG. 5 where "AR1" follows the question mark, "?". The HTTP network address and the Argument Symbol, "AR1," constitute the request corresponding to the Linked Term, "AUTOMOTIVE-RELATED INDUSTRY." The request comprises a request header specifying a purpose of the request ("http"), the network address of Proxy Server 207 to which the request header is applied ("www.example.com"), a file name of an application that is stored on Proxy Server 207 ("datasite.pl"), and an argument that acts as a key in a table lookup and corresponds to the request ("AR1"). When the user clicks on the Linked Term, "AUTOMOTIVE-RELATED INDUSTRY," it is determined at step 251 whether the user must be authenticated. Thereafter, if there is a need to authenticate the user, the user is authenticated,

in a first authentication process, by the Proxy Server at step 252 before proceeding to step 253. Otherwise, the process is continued at step 253 without the first authentication. Thereafter, the browser passes the request, including the Argument Symbol, to the CGI application on the Proxy Server 207 (shown in FIG. 4). For example, if the term AUTOMOTIVE-RELATED INDUSTRY is linked to three separate Database Servers, there will be three Argument Symbols AR1, AR2 and AR3 assigned to the term where each Argument Symbol contains the separate network address of each one of the Database Servers. Although FIG. 5 uses as an example Argument Symbols A1 . . . A10, there is in reality no limit to the number of databases to which a Linked Term can be connected, and therefore FIG. 5 should not be construed as a limitation.

The Argument Symbol is used as a key in a table lookup on the Proxy Server that is implemented as a hash table, associative array or a linked list. The table look up matches the key with the expert-predetermined optimum values for the Database Servers' network address and query.

Thus, browser 204 sends a request to Proxy Server 207 (shown in FIG. 4). The request comprises a request header which specifies the purpose of the request, the network address of the Proxy Server 207, the file name of an application that is stored on the Proxy Server 207, and an argument that acts as a key in a table lookup and corresponds to the Linked Term associated with the request. In a preferred embodiment, the request, including the request header, is sent to the Proxy Server 207 via a collaborative information systems transmission protocols used on a network which include a combination of Hypertext Transfer Protocol (HTTP) and Transmission Control/Internet Protocol (TCP/IP), including TCP/IP version 6.0.

Alternatively, the argument that acts as a key or the key can be used to create a pop-up or floating window display for viewing by the user. The window display presents the user with a menu of choices for further areas of research pertaining to the key and, therefore, the Linked Terms. Each choice corresponds to an Argument Symbol. The user chooses one of the options presented, which will send an Argument Symbol to Proxy Server 207 that is used as a key in a table lookup on Proxy Server 207. The table lookup then matches the key with one of a plurality of expert-predetermined optimum values used to retrieve records from the Data Warehouse or database. Each expert predetermined optimum value includes a network address for the Database Server, a query argument, and an authentication argument. In other words, the user by selecting one of the choices causes an application that is executed on Proxy Server 207 to match a key, corresponding to the selected choice in the table lookup, with a request header comprising a purpose of the request, a network address for a database network resource to which the request header is applied, a file name for an application that is stored on the database network resource, a query argument and an authentication argument. Additionally, the selection of the choice by the user causes the application that is executed on Proxy Server 207 to send the request header to the database network resource, e.g., Data Warehouse 230 or a database.

Next, the CGI application is executed, as shown at 253. At step 254, the CGI application finds and sends to the browser the file which contains the HTML code that causes the browser to subdivide its main viewing window into a series of frames 262, 263, 264 and 265. Simultaneously, at step 255, the CGI application correlates the Argument Symbol with the network address of the Database Server and the query argument chosen to be inserted in the database's or

Data Warehouse's search engine, and sends a request header to the Database Server 211 (shown in FIG. 4). An authentication argument (e.g., a user name and password) and a query argument are coupled to the request (which includes a request header) corresponding to the Linked Term selected by the user. The request header includes a purpose of the request (e.g., http), a network address of the network resource to which the request header is applied, a file name for an application on the network resource to which the request header is applied and alphanumeric arguments that contain the user ID; password and search query 255. (The authentication argument is used to access a database or Data Warehouse that may require authentication prior to allowing access to files or records in the database or Data Warehouse.) Thereafter, the request header, the authentication argument and the query argument are sent to the database or Data Warehouse. In another embodiment, the request header, the authentication argument and the query argument are sent to the Database Server 211 associated with the database or Data Warehouse. Thereafter, the Database Server 211 parses the request header and sends the authentication argument and the query argument directly to the database or Data Warehouse. If the Database Server performs the authentication, then just the query argument will be sent to the database or Data Warehouse. The Database Server takes the query argument and passes it through the Database Interface 220 (shown in FIG. 4) to the Data Warehouse 257. The Data Warehouse search engines locate the records and send them back through the Database Interface 220 (shown in FIG. 4) and the Database Server 211 (shown in FIG. 4) to the (e.g., datasite.pl) on the Proxy Server for further processing, which will be described below.

FIG. 6, shows the resulting view in the browser as a consequence of the Document Server's response to a user's request for a document. Browser window 300 is the initial screen of the document sent by the Document Server 202 (shown in FIG. 4). Browser window 301 shows the same document after the user scrolls down to a Linked Term 303 he or she wants to see. In one embodiment of the invention, such as that shown in FIG. 6, the hyperlinked term can have hyperlinked symbols 305 following immediately after the term which indicate to the reader the properties of the media linked to the Linked Term. For example, a "speaker" symbol will indicate audio content, a "film strip" segment symbol will indicate video and a "document" symbol will indicate text. These symbols could appear singly or in groups depending on the nature and properties of the content connected.

FIG. 7 shows a view of the browser window after it has been divided into four frames. When the user clicks on the Linked Term, the browser sends a request to the Proxy Server. All or only some of the frames may be scrollable in either an up and down direction, or in a side-to-side direction. The Proxy Server responds by outputting HTML <FRAMESET> and <FRAME> elements that are described in the CGI application on the Proxy Server causing the browser's windows to subdivide into four frames 400, 401, 402, and 403 and 254, 262, 263, 264 and 265 (shown in FIG. 5). It is to be noted that the present invention is not limited to subdividing the browser's window into four frames, as shown in FIG. 7. Therefore, in the other embodiments, the browser's window may be divided into any number of frames arranged in any desired way.

For instance, as a result of clicking on the link "AUTOMOTIVE-RELATED INDUSTRY", the browser sends the request header `http://www.example.com/datasite.pl?AR1` to the Proxy Server located at the network

address "www.example.com". The Proxy Server parses the incoming request, and locates the CGI application "datasite.pl". The Proxy Server then executes "datasite.pl" and outputs HTML <FRAMESET> and <FRAME> element to the browser 254 (shown in FIG. 5), causing the browser to parse the HTML elements. As the browser parses the HTML elements, it causes the main viewing window in the browser to subdivide into four frames 400, 401, 402 and 403. The characteristics of the frames' functionality are as follows:

Each frame can load a network address independently of the other frames;

Each frame can be given a specific name (using the HTML "NAME" tag), allowing it to be targeted by other request headers;

Each frame can resize itself dynamically in response to changes in the size of its visible area, or it can be set to disallow dynamic resizing or manual resizing by a viewer; and

The frames can either be standard fixed frames or floating frames.

Each frame may be set to scroll or not to scroll.

In addition to the frames, the HTML code sent to the client specifies text, audio, graphics or video files (or documents) or some combination thereof, to be pulled in from other directories on the Proxy Server, and/or from other remote servers across the Internet or within an intranet, and into predetermined nested frames on the client application. The HTML code in the CGI application on the Proxy Server which calls for the documents from the Database HTTP Server can specify the frames to which the file would be loaded by using the TARGET element and specifying the attribute given to the frame's NAME element.

For example, when the HTML code sent by the CGI application on the Proxy Server loads into the browser, it may contain a FRAMESET tag, which is nested within a second FRAMESET tag, which is further nested within a third FRAMESET tag.

Each FRAMESET tag is placed in the space that would be used for the corresponding frame if it had been a FRAME tag instead of a nested FRAMESET. When the browser parses the HTML code from the Proxy Server, the browser will first divide the browser's window into two separate frames in a 78% to 22% ratio (the 78% window is 400 and the 22% window is the sum of the areas of 401, 402 and 403). Next, the browser will subdivide the 22% window into a 47% to 53% ratio (the 53% window is 402 and the 47% window is the sum of the areas of 401 and 403). Finally, the 47% window is further subdivided into a 72% to 28% ratio (the 72% window is 401 and the 28% window is 403).

FIG. 8 shows frames 1 to 4 of the browser's window filled with multimedia content received concurrently from both the Proxy Server and the Database Server 258, 259, 260 and 261 (shown in FIG. 5). Frame 1 500 is identified with a named attribute of the FRAME element such as NAME=frame 1, where "frame 1" is the attribute of the element "name". In the present invention, the FRAME element located within the CGI application ("datasite.pl") on the Proxy Server holds the SRC element (see example below) for the hyperlink, and passes to the Database Server the authentication argument (password and user ID) and the query argument for the Data Warehouse's search engine through a QUERY_STRING environment variable annexed after the "?." The NAME attribute refers to the name of a particular frame (frame 1, frame 2, etc.), and the HTML document referred to in the SRC element is automatically loaded into that named frame. So, the results of the search called for by the SRC element below would be loaded into frame 1 500.

The FRAME elements within the nested FRAMESETS located within datasite.pl look like this:

```
<FRAMESET ROWS="78%, 22%">
<FRAME
SRC="http://www.database.com/directory 1/CGI.pl?
  userID=X & password=Y & SEARCH=Z
<FRAMESET ROWS="47%, 53%">
<FRAMESET COLS="72%, 28%"><FRAME
SRC="up1-a1~1.html" NAME="frame2"
  MARGINWIDTH="1" MARGINHEIGHT="1"
  SCROLLING="NO">
<FRAME
SRC="cibc12~1.html" NAME="frame4"
  MARGINWIDTH="1" MARGINHEIGHT="1"
  SCROLLING="NO"></FRAMESET>
<FRAME
SRC="lnk1-2~1.html" NAME="frame3"
  MARGINWIDTH="1" MARGINHEIGHT="1"
  SCROLLING="AUTO"></FRAMESET>
</NOFRAMES>
```

where "www.database.com" is the URL of the database; "directory 1" is the directory on the server where the CGI application is located; "CGI.pl" is the Data Warehouse's CGI application located on the Database Server and X, Y and Z are the alphanumeric arguments that contain the user ID, password and search query, respectively, and which are passed to CGI.pl by the QUERY_STRING environment variable. The contents called for by the SRC hyperlink "www.database.com" are automatically loaded into frame 1 500; 261 and 262 (shown in FIG. 5). Likewise, the contents called for by the SRC hyperlink up1-a1~1.html would be loaded in frame 2 501; 258 and 263 (shown in FIG. 5); the contents called for by the SRC hyperlink cibc12~1.html would be loaded in frame 4 503; 260 and 265 (shown in FIG. 5) and the contents called for by SRC hyperlink lnk1-2~1.html would be loaded in frame 3 502; 259 and 264 (shown in FIG. 5).

It is to be noted that a second environment variable, such as PATH_INFO, can be used to pass data to the CGI.pl application. Furthermore, one can also use METHOD=POST, and pass the data by stdin and stdout in the same fashion. Since the CGI application (datasite.pl), and not the browser, makes the request to the Database Server, the user will not see either the passwords or user ID's on the command line of the browser if the QUERY_STRING environment variable is used.

A second embodiment of the invention could include vendor extensions for faster CGI access, for example Oracle's Web Request Broker, or non-CGI programmatic server extensions such as Microsoft's Internet Server API (ISAPI) and the Netscape API (NSAPI).

In a third embodiment of the present invention, the CGI application may be replaced as a means to pass data by employing a non CGI programmatic object oriented communications protocol, such as Java Servlet API, in an application performing the table look-up of the that is executed on the Proxy Server, and have the Java Servlet API communicate data to a Java-enabled Database Server and a Java enabled browser. Such an embodiment would avoid the slowness of passing data through stdin and stdout, of QUERY_STRING environment variables as is done by the CGI application, thereby speeding up the data transfer process by allowing the application performing the table look-up on the Proxy Server to run continuously instead of stopping and starting on demand as a CGI application would

do, and permitting the server's memory to cache data. The Java Servlet API also permits the servers and client to establish end to end (browser to Proxy Server to Database Server and back) channel security through Secure Sockets Layer (SSL) or Secure HyperText Transport Protocol (S-HTTP). It would also encrypt all data passing from the client to the Proxy Server and from the Proxy Server to the Database Server.

A fourth embodiment of the invention would use a non CGI programmatic object oriented communications protocol employing embedded applications, such as Sun Microsystems's Java applets or Microsoft's Active X, containing authentication arguments and query arguments for all the selected databases connected to the document. These embedded applications can be encrypted. For example, the applets would be downloaded from the Proxy Server to the browser, which would permit the browser to independently gain access to the various databases and Data Warehouses without continuously using the resources of the Proxy Server. Presently this is not possible with Java applets since there is a restriction for security reasons on the functionality of the applet. Presently, applets can only communicate to the server from where they were received, which in this case would be the Proxy Server. Applets cannot presently connect to other servers. Also, applets cannot inspect or change files on the local hard drive or spawn other programs, including other applets. However, these limitations are expected to be lifted once certificate based public-key cryptographic systems and digital signature based systems are perfected.

The fourth method and its corresponding apparatus operate as follows. A browser sends a request (which is in the form of a request header), corresponding to at least one link in a file of information on the Document Server to the Proxy Server. The Proxy Server, in response to receiving the request, executes an application and sends at least one embedded application, preferably encrypted, to the browser. In one embodiment, the embedded application is Sun Microsystems's Java applet. In a second embodiment, the embedded application is Microsoft's Active X. The encrypted embedded application is executed on the browser and couples an authentication argument and a query argument with the request header. Thereafter, the browser sends the request header, the query argument and the authentication argument to the Database Server. It is to be noted that the authentication argument need only be coupled to the request header and sent to the Database Server if the Database Server requires authentication for providing access to files in the database or Data Warehouse. The browser also causes the database or Data Warehouse to search for records that satisfy the query argument. Simultaneously, the embedded application that is executed on the browser causes the browser to subdivide its display window into four frames. Furthermore, the embedded application that is executed on the browser displays at least one record that satisfies the query argument in the largest of the four frames. The embedded application also causes a series of graphic symbols (e.g. buttons corresponding to a plurality of arguments) for selecting a plurality of databases to appear in at least a second of said four frames for enabling the user to select one of a plurality of databases. In a preferred embodiment, the embedded application that is executed on the browser, further causes the browser to subdivide its display window into a second set of frames to replace the four frames. The embedded applications causes a list of index terms to be displayed in at least one of the frames in the second set of frames. The index terms are for selecting the Linked Term in the file of information on the Document Server.

In one embodiment, the above method further involves determining whether a first authentication of a user is needed for sending the request to the Proxy Server; and authenticating the user if such authentication is required.

In a preferred embodiment, the request header includes an Argument Symbol that acts as a key in a table lookup that is implemented as a hash table, associative array or a linked list. Furthermore, the embedded application that is executed on the browser correlates in a table lookup the key with one of a plurality of expert predetermined optimum values, where each expert predetermined value includes a network address for a database or Data Warehouse, a query argument, and an authentication argument. Alternatively, the key can be used to create a pop-up or floating window display for viewing by the user. The window display presents the user with a menu of choices for further areas of research pertaining to the Linked Terms where each choice corresponds to an Argument Symbol. The user chooses one of the options presented, which will send an argument that is used as a key in a table lookup in an embedded application that is executed on the browser. The table lookup then matches the key with one of a plurality of expert-predetermined optimum values used to retrieve records from the Data Warehouse or database. Each expert predetermined optimum value includes a network address for the Database Server, a query argument, and an authentication argument. In other words, the user by selecting one of the choices causes an embedded application executing on browser 204 (shown in FIG. 4) to match a key, corresponding to the selected choice in the table lookup, with a request header comprising a purpose of the request, a network address for a database network resource to which the request header is applied, a file name for an application on the database network resource, a query argument and an authentication argument. Additionally, the selection of the choice by the user causes the embedded application executing on browser 204 to send the request header to the Database Server 211 which passes it to the Data Warehouse 230 or a database through the Database Interface 220 (all shown in FIG. 4).

In one embodiment, the expert predetermined optimum values and the keys are stored on the Proxy Server and are sent to the browser in response to a request to that effect by the browser. Once the browser receives the data, it executes the embedded application and matches one of the expert predetermined optimum values with a key in the table lookup.

In a preferred embodiment, the embedded application executing on the browser sends a request header that includes the following: a) a purpose of the request; b) a network address for a Database Server, a database or Data Warehouse to which the request header is applied; c) a file name for an application stored on the Database Server; d) a query argument; and e) an authentication argument.

The Database Server, in response to receiving the request header, the authentication argument and the query argument, authenticates the user, and passes the query argument to the Data Warehouse 230 or a database through the Database Interface 220 (all shown in FIG. 4). The database or Data Warehouse executes a search and returns to the browser records that satisfy the query argument. In another embodiment, a database or Data Warehouse directly receives a request, an authentication argument and a query argument, authenticates the user, executes a search and returns to the browser records that satisfy the query argument. In one embodiment, an application that is executed on the Proxy Server or the embedded application that is executed on the browser modifies the record that satisfies the query argument

and, thereafter sends the record to the browser. The embedded application that is executed on the browser causes the record that satisfies the query argument to appear in the largest of the four frames created on the browser's window. The embedded application executing on the browser also causes a plurality of buttons corresponding to a plurality of arguments for selecting a plurality of databases to appear in the second of the four frames on the browser's window (i.e., the means for selecting a plurality of databases). These buttons include arguments that act as keys in the table lookup with all the keys corresponding to a Linked Term in the aforementioned file of information on the Document Server. The user by clicking on one of the buttons causes the embedded application that is executed on the browser to match the key corresponding to clicked button and causes the embedded application to generate a second request header that includes the following information: a) a purpose of the request; b) a network address for a database network resource (e.g., the Database Server 211) (shown in FIG. 4) to which the second request header is applied; c) a file name for an application stored on the Database Server; d) a query argument; and e) an authentication argument. Additionally, the embedded application that is executed on the browser causes an excerpt of text that includes the selected link in the file of information to appear in the third one of the four frames on the browser's window. Finally, the embedded application executing on the browser causes information associated with the source of the file of information to appear in the fourth of the four frames in the browser's window.

It is to be noted that the embedded applications sent to the browser depend on the type of functions that one desires to transfer from the Proxy Server to the browser. Thus, at one extreme, one or more embedded applications are sent to the browser to allow it to perform all the functions that would otherwise be performed by the applications on the Proxy Server. At the other extreme no embedded applications are sent to the browser, in which case all the functions that are performed by the applications on the Proxy Server in the earlier described embodiments (without the transfer of embedded applications from the Proxy Server to the browser), continue to be performed by the applications on the Proxy Server. In such an embodiment, the applications on the Proxy Server would perform the functions performed on the browser by the execution of the embedded application (s). It is also to be noted that the range of functions, transferred from the second network resource (i.e., the Proxy Server) to the browser, between the above two extremes is also covered within the scope of the present invention. Thus, in one embodiment of the present invention, some but not all of the functions that would otherwise be performed by the applications on the Proxy Server are served by the browser.

The second FRAME element automatically loads the contents of the first of a series of HTML files into frame 2 501. These HTML files contain the graphic images of button bars, with each button bar linked in its HREF statement to a specific network address of a network resource, such as a Database Server, a database or a Data Warehouse. These button bars alternatively appear in frame 2 501 as "pressed" or "down", or not pressed or "up," every time a viewer presses a button bar. Such actions can be accomplished in HTML code, or C++, ActiveX, Java, JavaScript, Visual Basic computer programs, or other programming languages 268, 263 (shown in FIG. 5).

Of course, it may be appreciated by someone familiar with the art that any graphic image, or selection process or scheme may be implemented as long as it shows the viewer

what databases or Data Warehouses have been selected and which ones have not. When a viewer clicks on a button bar linked via an HTTP address to a remote database or Data Warehouse, the HTML file associated with the button bar causes the viewer's browser to make a request for a record from the specified database or Data Warehouse in the same manner as described above for the initial QUERY-STRING request, with the results of the request displayed in frame 1 500. At the same time, the button bar that the viewer has clicked appears in frame 2 501 as depressed, with the remaining button bars appearing not pressed or up. The same process described above is repeated for the other remaining button bars, each time a viewer presses a button bar.

Simultaneously with the initial loading of content in frame 1 500 and frame 2 501, an HTML file located on the Proxy Server, containing the logos of the corporate firm sponsoring the access to the updated information, and the firm which has arranged the access to the database, or any other pertinent corporate logo or information appears in frame 4 503.

Finally, also simultaneously with the initial loading of content in frame 1 500, frame 2 501, and frame 4 503, the surrounding 15 or so words to the text which the viewer initially saw and clicked on will appear in frame 3 502. The same Linked Terms in area 303 of FIG. 6 will be highlighted in area 504 of FIG. 8. This frame and link provides the user when he or she clicks on the link, with a means to view the entire document, automatically scrolled to the place where the link appears from the Document Server, as was illustrated in FIG. 6.

It is to be noted when the Database Server 211 returns either the initial menu of results to `datasite.pl` on the Proxy Server or the final document that the user chose from the menu to `datasite.pl` on the Proxy Server (FIG. 10; 500 and FIG. 11), `datasite.pl` can strip away certain predetermined HTML tags from the document. This facility would be useful, for example, if specific banners or links to other areas of the Data Warehouse need to be disabled before it reaches the user's browser.

The arrangement of frames allows the viewer to view simultaneously the results of his or her search in frame 1 500, determine via frame 2 501 which button was depressed and which database has been selected, observe the corporate sponsor of the service in frame 4 503, and view the surrounding 25 to 30 words surrounding the highlighted text in frame 3 502. By clicking on the highlighted selection in frame 3 504, the user may return to the original full text of the document he or she was viewing and automatically scroll to the exact place in the full text document which the Linked Term occurs.

FIG. 9 illustrates a means to enlarge the viewing area of frame 1 500. This may be accomplished through a series of small graphic buttons 601, which when clicked, will cause a window containing only frames 1 500, frame 2 501 and frame 4 503, without frame 3 502 to appear, as shown in display 602. By clicking on another button in Frame 4 603, the viewer may cause frame 3 502 to reappear. Other buttons or graphical devices on the display window may also be used to increase and/or decrease the viewing area of any frame on the display window in a manner well known to those skilled in the art.

FIG. 10 illustrates the display screen after the user invokes the expert embedded judgment and the database or Data Warehouse returns the results. The user is presented with a menu of choices with a brief summary attached corresponding to a selection of text, audio, graphics or video files or documents from which he or she can choose. The

Data Warehouse or database organizes the returned records in a menu format. The user may adjust the screen in the manners described above using the graphic buttons 601 if he or she wishes, or choose a text, audio, graphics, or video document or file from area 500 of the main screen, one such selection being 604. The user may also return to the originating document 502 by clicking on the highlighted Linked Term 504. The user also has the option of choosing another Data Warehouse or database by clicking on any one of the buttons in frame 2 501. Once the user makes his or her choice, the Data Warehouse or database will deliver the document corresponding to the choice in frame 1 500.

FIG. 11 illustrates the browser's window including the "Infodex" feature of the preferred embodiment of the present invention. An "Infodex" button may be situated either in frame 2 700, or in some other suitable area of the GUI. A second button may be situated on the main document itself. In the embodiment shown in FIG. 6, that button 304 is located just under the masthead of the newsletter. By pressing the Infodex button, a viewer activates a link to the Proxy Server and makes a request through his or her browser for an HTML document containing two equal frames.

FIG. 12 is a flowchart of the method of operating the "Infodex" indexing process of the present invention. At step 750 in FIG. 12, the user chooses the Infodex button. By clicking on the button, the user passes an argument by the QUERY_STRING HTTP protocol to the CGI application, `infodex.pl` on the Proxy Server. At step 751, the Proxy Server executes the CGI application `infodex.pl`. As a result, at step 752 an HTML document containing an index of all the Linked Terms and their associated Data Warehouses or databases appearing in the originating HTML document is dynamically created. Simultaneously, at step 755, `infodex.pl`, more specifically, the "frames" subroutine therein, creates two frames, FRAME 1 757 and FRAME 2 756 in the browser's window. At 754, `infodex.pl` then sends the dynamically created index file to FRAME 1 757.

Simultaneously, at 753, `infodex.pl` sends a static HTML file that explains how to use Infodex or other such useful information to FRAME 2 756. As indicated in block 758, the user can click on a link in the index (in FRAME 1 757) and send a request header to `infodex.pl` on the Proxy Server, which then sends a request header to the Document Server. The Document Server then sends the originating document, scrolled to the exact place of the Linked Term to the Proxy Server, or even directly to the browser, if that is desired. If the Document Server sends the file to `infodex.pl` on the Proxy Server, `infodex.pl` will forward the file to the browser and insert it in frame 2. At this point, the user can initiate the process illustrated in FIG. 5 by clicking on the highlighted Linked Term.

FIG. 13 shows the browser's window as a result of operating the "Infodex" feature. As a result, left frame 803 is shown after it is automatically loaded with a dynamically created HTML document 800 in HTML created by Java, JavaScript, C++, Visual Basic or ActiveX, or any combination thereof, or any other relevant computer programming language. In document 800 the Linked Terms of the main document are presented in an expandable file tree index 805. By clicking on any one of the words, phrases, sentences or paragraphs with a symbol next to it, or on the "Expand" key 801 at the bottom of left frame 803, a branch of the tree expands below the "parent" limb, revealing on the "child" limb the names of all the Data Warehouses or databases linked to the Linked Terms represented by the "parent" limb.

At the same time, right frame 804 loads an HTML document 802 which explains how to use Infodex or other

such useful information. Both the right and the left frames are scrollable in either an up and down direction or in a side to side direction.

FIG. 14 shows the browser's window including "parent" limb 900 and "child" limb 901 in left frame 803. The viewer may then click the "child" limb 901 in the left frame 803, which causes the viewer's browser to request and load the full multimedia document in the right frame 804 and scroll to the area of the document that contains the Linked Term to the selection in left frame 803. FIG. 15 shows right frame 804 loaded with a document 1000 including Linked Term 1001 which is related to the "parent" whose "child" 901 the viewer clicked on. As shown in FIG. 15, the viewer will be able to see simultaneously, in left frame 803, an index of all the Linked Terms linked to a remote database or Data Warehouse, and in the right frame 804, the full text of the document 1000 scrolled to the Linked Term and its surrounding text. If the viewer chooses, he or she may scroll from the beginning to the end of the entire document 1000 in right frame 804. This document is the same document discussed above and illustrated in FIG. 6, and referenced as document 301. Accordingly, the viewer may click on the Linked Term in document 1000 and activate the same process discussed above and illustrated in FIGS. 4 to 10 above.

Thus, a cost-effective, highly efficient method and apparatus for automatically and continuously updating on demand an information source situated on a network resource has been described. Moreover, the method and apparatus has the additional advantages of causing the automatic updating of any document containing a Linked Term with information (current or archived) to expand and add depth and context to any document. For example, it permits:

Departments within corporations to update critical internal documents, such as 401K plan information, for their employees without labor intensive efforts;

The information services department of corporations to distribute updated information on software used by employees by first describing the software in a text document, and then using the invention to link to any network resource which holds documents pertaining to the update.

A corporation to have its sales force make personal sales calls, distribute print documents at the time of the sales call, and then update those distributed documents over a network, such as the Internet.

Automatic updating of print documents handed out at seminars and conferences.

Physicians to place descriptions of treatments for particular patients suffering from illnesses in password protected areas of a web site, and then have the information on the latest advances of drugs, or the legal status of FDA approval of drug updated regularly.

While the present invention has been particularly described with respect to the illustrated embodiment, it will be appreciated that various alterations, modifications and adaptations may be made based on the present disclosure, and are intended to be within the scope of the present invention. While the invention has been described in connection with what is presently considered to be the most practical and preferred embodiment(s), it is to be understood that the present invention is not limited to the disclosed embodiment(s) but, on the contrary, is intended to cover various modifications and equivalent arrangements included within the scope of the appended claims.

For example, other gateway applications besides CGI, such as Sun Microsystems Incorporated's Java; Microsoft's Internet Server API (ISAPI) and Netscape's API (NSAPI), Java, Java applets, and Oracle's Web Request, may be used for transmission of data between the Proxy Server any other HTTP server. Also, immediately following the Linked Terms, graphic symbols for audio, video and text may be added to indicate to the reader the properties of the content to which the user gained access. Moreover, once the user accesses the database or Data Warehouse and views the information he or she sought, a window could appear which would allow the user to further refine the search by entering additional search terms and running another search in the database or Data Warehouse. Other embodiments would also include substituting std in and std out as a means to pass data through CGI to the Database HTTP Server instead of QUERY_STRING or PATH_INFO environment variables, or using Java, Java applets or enhanced CGI as detailed above.

What is claimed is:

1. A method of dynamically augmenting the contents of at least one file of information on a first network resource, said file of information having at least one link, said method comprising the steps of:

creating at least one request corresponding to said at least one link;

coupling at least one query argument with said at least one request;

providing a database;

sending said at least one request and said at least one query argument to said database;

causing said database to search for at least one record that satisfies said at least one query argument;

providing a display for viewing by a user;

subdividing said display into a plurality of frames;

displaying said at least one record that satisfies said at least one query argument in at least a first frame of said plurality of frames; and

providing a series of graphic symbols in at least a second frame of said plurality of frames for enabling the user to select one of a plurality of databases.

2. The method of claim 1, further comprising the steps of: subdividing said display into a second plurality of frames which replace said plurality of frames; and

providing a list of index terms in at least one frame of said second plurality of frames, said index terms for selecting said at least one link in said at least one file of information on said first network resource.

3. The method of claim 1, wherein said step of coupling further comprises coupling at least one authentication argument to said at least one query argument and said at least one request.

4. A method of dynamically augmenting the contents of at least one file of information on a first network resource, said file of information having at least one link, said method comprising the steps of:

creating at least one request corresponding to said at least one link;

coupling at least one authentication argument and at least one query argument with said at least one request;

providing a database;

sending said at least one request, said at least one query argument and said at least one authentication argument to said database;

causing said database to search for at least one record that satisfies said at least one query argument;
 providing a display for viewing by a user;
 subdividing said display into a plurality of frames;
 displaying said at least one record that satisfies said at least one query argument in at least a first frame of said plurality of frames; and
 providing a series of graphic symbols in at least a second frame of said plurality of frames for enabling the user to select one of a plurality of databases.

5. The method of claim 4, further comprising the steps of providing:
 subdividing said display into a second plurality of frames which replace said plurality of frames; and
 a list of index terms in at least one frame of said second plurality of frames, said index terms for selecting said at least one link in said at least one file of information on said first network resource.

6. The method of claim 4, wherein said step of sending said at least one request is performed by a browser, further wherein said at least one request comprises a request header specifying: a) a purpose of the request; b) a network address of a second network resource to which said request header is applied; c) a file name for an application that is stored on said second network resource; and d) an argument that acts as a key in a table lookup, and corresponds to said at least one link.

7. The method of claim 6, wherein said request header is sent to said second network resource via collaborative information systems transmission protocols used on a network.

8. The method of claim 7, wherein said collaborative information systems transmission protocols used on a network include the combination of Hypertext Transfer Protocol (HTTP) and Transmission Control/Internet Protocol (TCP/IP), including TCP/IP version 6.0.

9. The method of claim 4, wherein said coupling step includes the step of executing an application stored on a second network resource, said application causing the coupling of said at least one authentication argument and said at least one query argument with said at least one request.

10. The method of claim 9, wherein said application that is executed on said second network resource uses as a gateway interface to the database a Common Gateway Interface (CGI) protocol interface.

11. The method of claim 9, wherein said application that is executed on said second network resource uses as a gateway interface to the database a gateway interface selected from the group consisting of non-Common Gateway Interface (CGI) programmatic object oriented communications protocols and non-CGI programmatic server extensions.

12. The method of claim 9, further comprising the steps of:
 determining whether a first authentication of a user is needed before said at least one request is sent to said second network resource; and
 performing said first authentication of the user if said first authentication of the user is required.

13. The method of claim 9, wherein said at least one request comprises an argument that acts as a key in a table lookup and wherein said application executes on said second network resource and correlates in said table lookup said key with one of a plurality of expert predetermined optimum values, each said expert predetermined value comprising a network address for a database, a query argument, and an authentication argument.

14. The method of claim 13, wherein said key can be used to create a window display for viewing by a user, said window display presenting the user with a menu of choices for further areas of research pertaining to said key.

15. The method of claim 14, wherein the user, by selecting one of said choices, causes said application that is executed on said second network resource to match a key, corresponding to said one of said choices in a table lookup, with a request header comprising: a) a purpose of the request; b) a network address for a third network resource to which said request header is applied; c) a file name for an application that is stored on said third network resource; d) a query argument; and e) an authentication argument; and causes said application on said second network resource to send said request header to said third network resource.

16. The method of claim 13, wherein said application that is executed on said second network resource matches one of said expert predetermined optimum values with said key in said table lookup selected from the group consisting of a hash table, an associative array and a linked list.

17. The method of claim 9, wherein said application that is executed on said second network resource generates at least a second request header comprising: a) a purpose of the request; b) a network address for a third network resource to which said second request header is applied; c) a file name for an application that is stored on said third network resource; d) a query argument and e) an authentication argument.

18. The method of claim 4, wherein said database authenticates a user; executes a search; and returns to a second network resource said at least one record that satisfies said at least one query argument.

19. The method of claim 4, wherein an application that is executed on a second network resource modifies said at least one record that satisfies said at least one query argument.

20. The method of claim 4, wherein an application that is executed on a second network resource causes a browser to subdivide said display into said plurality of frames.

21. The method of claim 20, wherein said application executing on said second network resource causes said at least one record that satisfies said at least one query argument to appear in the largest frame of said plurality of frames.

22. The method of claim 20, wherein said application that is executed on said second network resource causes a plurality of buttons corresponding to a plurality of arguments for selecting a plurality of databases to appear in at least a second frame of said plurality of frames.

23. The method of claim 22, wherein said plurality of buttons comprise arguments that act as keys in a table lookup, with all said keys corresponding to a specific link in said at least one file of information on said first network resource.

24. The method of claim 23, wherein the user, by clicking on one of said plurality of buttons, causes said application on said second network resource to match said key corresponding to said button in said table lookup with a third request header comprising: a) a purpose of the request; b) a network address for a third network resource to which said third request header is applied; c) a file name for an application that is stored on said third network resource; d) a query argument; and e) an authentication argument and causes said application on said second network resource to send said third request header to a third network resource.

25. The method of claim 4, wherein an application that is executed on a second network resource causes an excerpt of text that includes said at least one link in said at least one file

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of information to appear in at least a third frame of said plurality of frames.

26. The method of claim 4, wherein an application that is executed on a second network resource causes information associated with the source of said at least one file of information to appear in at least a fourth frame of said plurality of frames.

27. The method of claim 4, wherein the user may cause through a graphical device on said display to increase and decrease a viewing area of any one of said plurality of frames.

28. The method of claim 4, wherein said at least one link is identified by icons selected from the group consisting of symbols representing text, audio, graphics and video information.

29. A method of dynamically augmenting the contents of at least one file of information on a first network resource, said file of information having at least one link, said method comprising the steps of:

- providing a browser;
- providing a second network resource having at least one application;
- creating at least one request corresponding to said at least one link;
- sending said at least one request to said second network resource, wherein said second network resource, in response to receiving said at least one request, executes said at least one application and sends at least one embedded application to said browser;
- coupling at least one authentication argument and at least one query argument with said at least one request;
- providing a database;
- sending said at least one request, said at least one query argument and said at least one authentication argument to said database;
- causing said database to search for at least one record that satisfies said at least one query argument;
- providing a display for viewing by a user;
- subdividing said display into a plurality of frames;
- displaying said at least one record that satisfies said at least one query argument in at least a first frame of said plurality of frames; and
- providing a series of graphic symbols in at least a second frame of said plurality of frames for enabling the user to select one of a plurality of databases.

30. The method of claim 29, further comprising the steps of:

- subdividing said display into a second plurality of frames which replace said plurality of frames; and
- providing a list of index terms in at least one frame of said second plurality of frames, said index terms for selecting said at least one link in said at least one file of information on said first network resource.

31. The method of claim 29, wherein said coupling step is executed on said browser by said at least one embedded application.

32. The method of claim 29, further comprising the steps of:

- determining whether a first authentication of the user is needed before said at least one request is sent to said second network resource; and
- performing said first authentication of the user if said first authentication of the user is required.

33. The method of claim 29, wherein said at least one request comprises an argument that acts as a key in a table

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lookup and said at least one embedded application is executed on said browser and correlates in said table lookup said key with one of a plurality of expert predetermined optimum values, each said expert predetermined value comprising a network address for a database, a query argument, and an authentication argument.

34. The method of claim 33, wherein said key can be used to create a window display for viewing by the user, said window display presenting the user with a menu of choices for further areas of research pertaining to said key.

35. The method of claim 34, wherein the user by selecting one of said choices causes said embedded application that is executed on said browser to match a key, corresponding to said one of said choices in a table lookup, with a request header comprising: a) a purpose of the request; b) a network address for a third network resource to which said request header is applied; c) a file name for an application that is stored on said third network resource; d) a query argument; and e) an authentication argument; and causes said embedded application that is executed on said browser to send said request header to said third network resource.

36. The method of claim 33, wherein said at least one embedded application requests said one of a plurality of expert predetermined optimum values and a plurality of said keys, associated with said link, from said second network resource.

37. The method of claim 33, wherein said at least one embedded application that is executed on said browser matches one of said expert predetermined optimum values with said key in said table lookup selected from the group consisting of a hash table, an associative array and a linked list.

38. The method of claim 33, wherein said at least one embedded application that is executed on said browser generates at least a request header comprising: a) a purpose of the request; b) a network address for a third network resource to which said request header is applied; c) a file name for an application that is stored on said third network resource; d) a query argument and e) an authentication argument.

39. The method of claim 29, wherein said database authenticates the user, executes a search and returns to said browser said at least one record that satisfies said at least one query argument.

40. The method of claim 29, wherein an application that is executed on said second network resource modifies at least one record that satisfies said at least one query.

41. The method of claim 29, wherein said at least one embedded application is executed on said browser and causes said browser to subdivide said display into said plurality of frames.

42. The method of claim 41, wherein said at least one embedded application that is executed on said browser causes said at least one record that satisfies said at least one query argument to appear in the largest frame of said plurality of frames.

43. The method of claim 41, wherein said at least one embedded application that is executed on said browser causes a plurality of buttons corresponding to a plurality of arguments for selecting a plurality of databases to appear in at least a second frame of said plurality of frames.

44. The method of claim 43, wherein said plurality of buttons comprise arguments that act as keys in said table lookup with all said keys corresponding to a specific link in said at least one file of information on said first network resource.

45. The method of claim 44, wherein the user, by clicking on one of said plurality of buttons, causes said at least one

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embedded application that is executed on said browser to match said key corresponding to said button in said table lookup and causes said at least one embedded application to generate a second request header comprising: a) a purpose of the request; b) a network address for a third network resource to which said second request header is applied; c) a file name for an application that is stored on said third network resource; d) a query argument; and e) an authentication argument.

46. The method of claim 41, wherein said at least one embedded application that is executed on said browser causes an excerpt of text that includes said at least one link in said at least one file of information to appear in at least a third frame of said plurality of frames.

47. The method of claim 41, wherein said at least one embedded application that is executed on said browser causes information associated with the source of said at least one file of information to appear in at least a fourth frame of said plurality of frames.

48. The method of claim 29, wherein the user may cause, through a graphical device on said display, to increase and decrease a viewing area of any one of said plurality of frames.

49. The method of claim 29, wherein said at least one link is identified by icons selected from the group consisting of symbols representing text, audio, graphics and video information.

50. The method of claim 29, wherein said step of providing said second network resource comprises providing a second network resource having at least one applet, further wherein said second network resource, in response to receiving said at least one request, sends said at least one applet to said browser.

51. An apparatus for dynamically augmenting the contents of at least one file of information on a first network resource, said file of information having at least one link, said apparatus comprising:

a browser having a display for viewing by a user;

a second network resource coupled to said browser, wherein said browser sends at least one request corresponding to said at least one link to said second network resource, further wherein said second network resource couples at least one query argument with said at least one request, said second network resource further causing said browser to subdivide said display into a plurality of frames; and

a database coupled to said second network resource, wherein said second network resource sends said at least one request and said at least one query argument to said database, said database comprising a search engine for searching for at least one record in said database that satisfies said at least one query argument; wherein said at least one record that satisfies said at least one query argument is displayed in at least a first frame of said plurality of frames and a series of graphic symbols are displayed in at least a second frame of said plurality of frames for enabling the user to select one of a plurality of databases.

52. The apparatus of claim 51, wherein said second network resource causes said browser to subdivide said display into a second plurality of frames to replace said plurality of frames and further wherein a list of index terms are displayed in at least one frame of said second plurality of frames, said index terms for selecting said at least one link in said at least one file of information on said first network resource.

53. The apparatus of claim 51, wherein said second network resource couples at least one authentication argu-

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ment to said at least one request and said at least one query argument, further wherein said second network resource sends said at least one request, said at least one query argument, and said at least one authentication argument to said database.

54. The apparatus of claim 53, wherein said second network resource further comprises a memory, said memory storing a table look up having a plurality of expert predetermined optimum values, each said expert predetermined optimum value having a network address for a database, a query argument, and an authentication argument, further wherein said at least one request comprises an argument that acts as a key in said table lookup, said key being correlated with one of said expert predetermined optimum values.

55. The apparatus of claim 51, wherein said second network resource is a proxy server.

56. An apparatus for dynamically augmenting the contents of at least one file of information on a first network resource, said file of information having at least one link, said apparatus comprising:

a browser having a display for viewing by a user;

a second network resource coupled to said browser, wherein said browser sends at least one request corresponding to said at least one link to said second network resource, further wherein said second network resource, in response to said at least one request, sends at least one embedded application to said browser; wherein said at least one embedded application is executed on said browser and couples at least one query argument with said at least one request, further wherein said at least one embedded application causes said browser to subdivide said display into a plurality of frames; and

a database coupled to said browser, wherein said browser sends said at least one request and said at least one query argument to said database, said database comprising a search engine for searching for at least one record in said database that satisfies said at least one query argument;

wherein said at least one record that satisfies said at least one query argument is displayed in at least a first frame of said plurality of frames and a series of graphic symbols are displayed in at least a second frame of said plurality of frames for enabling the user to select one of a plurality of databases.

57. The apparatus of claim 56, wherein said second network resource causes said browser to subdivide said display into a second plurality of frames to replace said plurality of frames and further wherein a list of index terms are displayed in at least one frame of said second plurality of frames, said index terms for selecting said at least one link in said at least one file of information on said first network resource.

58. The apparatus of claim 56, wherein said at least one embedded application is executed on said browser and couples at least one authentication argument to said at least one request and said at least one query argument, further wherein said browser sends said at least one authentication argument, said at least one request and said at least one query argument to said database.

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59. The apparatus of claim 56, wherein said at least one embedded application is executed on said browser and causes said browser to send said at least one request and said at least one query argument to said database.

60. The apparatus of claim 58, wherein said second network resource further comprises a memory, said memory storing a table look up having a plurality of expert predetermined optimum values, each said expert predetermined optimum value having a network address for a database, a

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query argument, and an authentication argument, further wherein said at least one request comprises an argument that acts as a key in said table lookup, said key being correlated with one of said expert predetermined optimum values.

61. The apparatus of claim 56, wherein said at least one embedded application comprises at least one applet.

* * * * *

CERTIFICATE OF CORRECTION

PATENT NO: 5,987,454

Page 1 of 2

DATED: November 16, 1999

INVENTOR(S): Allen Hobbs

It is certified that error appears in the above-identified patent and that said Letters Patent are hereby corrected as shown below:

[54] Title, after "CHARTS," insert --TABLES,--.

Column 1, line 18, delete "sheet;" and substitute therefor --sheets);--.

Column 2, line 56, after "MAGELLAN" insert ",".

Column 6, line 23, delete "Binder" and substitute therefor --Bindery--.

Column 9, line 52, delete "FIG. 5" and substitute therefor --FIGS. 5A and 5B--.

Column 9, line 54, delete "FIGS. 6, 7, 8, 9, 10 and 11" and substitute therefor --FIGS. 6A, 6B, 7, 8, 9A, 10 and 11--.

Column 9, line 56, delete "FIG. 5" and substitute therefor --FIGS. 5A and 5B--.

Column 10, line 20, delete "maybe" and substitute therefor the words --may be--.

Column 15, line 10, after "frames" delete "," and substitute therefor --;--.